SCANNED

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COVER PICTURE

Our cover picture shows Mullewa countryside festooned with "Pom Pom" everlastings

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Banana Cultivation at CARNARVON

By J. A. LAWSON, B.Sc. (Agric.), Agricultural Adviser, North-West Division

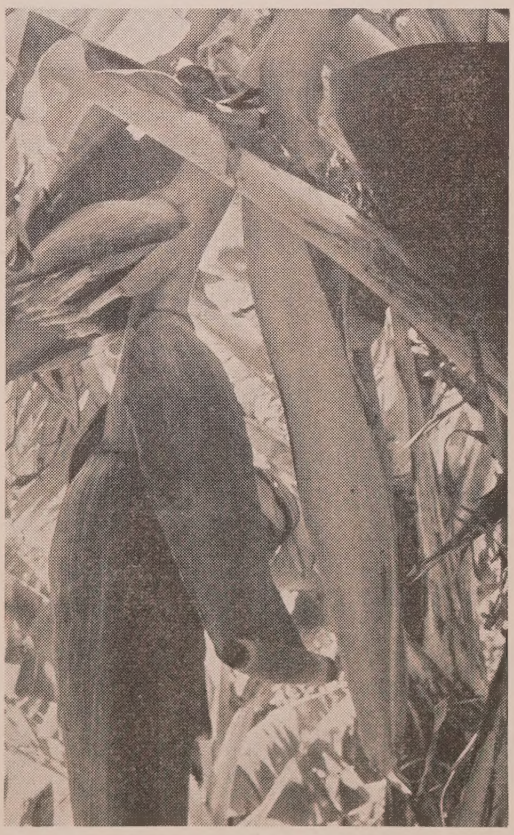
THE banana is claimed by some authorities to be the first fruit ever used by man. Indeed, it is so widely scattered throughout the tropical countries of the world that it is very difficult to name its centre of origin. For centuries it has been regarded as one of the most useful fruits for treating patients with digestive ailments, and over the last few decades it has been recommended by doctors, particularly for infants. Although the protein content of bananas is low, the sugars of the ripened fruit are present in a most useful form, and the vitamin content, by comparison with other fruits, is of quite a high level.

The banana is actually a member of the order *Iridales*, that is, it is related to Irises, etc., and belongs to the family *Musaceae*. It has a tuberous underground stem or rhizome (erroneously known as a corm) and the above-ground "trunk" is actually a pseudo-stem composed of leaf sheaths. In most of the domestic varieties no fertilisation of the fruit takes place, and as a bunch emerges, three types of flowers are produced; females at the top, then a number of hermaphrodites, and the remainder at the "tassel" end, males. The ovules of the female flowers form the fruits, which, due to the lack of fertilisation, contain no seeds.

Until recent years, the most important banana variety of commerce has been the Gros Michel (*Musa sapientum*), but this, due to its susceptibility to a fusarium wilt (Panama disease), is now losing popularity, and Cavendish types (*Musa cavendishii*) are being planted in most of the world's commercial growing areas.

In Western Australia, the only commercial area of bananas in production is at Carnarvon, and as will later be mentioned, they are grown in most unusual conditions by comparison with those in other parts of the world.

In 1947 an excellent pamphlet was prepared by the Tropical Adviser at the time, Mr. G. B. Barnett, and this was a useful handbook for earlier banana growers. Some agricultural practices have changed in recent years, and the following article contains present Departmental recommendations.



Newly emerged banana floret

DESCRIPTION OF THE AREA AND OF THE INDUSTRY

Carnarvon is situated 612 road-miles north of Perth, just 98 miles below the Tropic of Capricorn, at the mouth of the Gascoyne River. The surrounding area is typical "semi-arid zone," with a rainfall of less than 9 inches per year, and vegetated principally with hardy drought-resistant shrubs and scrub trees, the dominant tree type being the Acacia. This is "sheep-station" country, with a carrying capacity varying from one sheep to 15 acres, to one sheep to 50 acres.

The mean variation of the rainfall is very high, and although the average may be 9 inches, the actual falls can be as low as two inches in any one year.

The area is favoured with an extremely mild winter climate, but summer can be somewhat trying, due to the constant high winds which blow during most afternoons; these are sometimes known as "Southerly Busters," and Carnarvon is said by some to be one of the windiest towns in Australia. Then, on occasions, during windless periods, temperatures of up to 120 degrees are sometimes recorded. The average relative humidity is surprisingly high (63 per cent.), probably due to the moisture laden nature of the southerly winds.

The banana plantations are situated on alluvial soils on the banks of the river, for a distance of 12 miles from the mouth, and at the present moment there are 136 operative. Their size ranges from 4 to 100 acres, and, generally speaking, each block has frontage to the "A" Class Reserve on the river bank.

On the south bank of the river (where more than half the district's bananas are grown) the soil is a deep, fertile loam. North bank soils are principally sandy loams varying to loamy sands in some areas. Gully soils are usually clay-loams. Early soil analyses class the soils as being moderately supplied with phosphates, well supplied with potash, but poor to medium in nitrogen.

Since the first banana consignment did not leave the district until 1930, the industry is only of very recent origin. It has experienced periods of economic depression, but also in more recent years has known great prosperity.

Very few growers concentrate on bananas alone: during the winter period, "out-of-season" vegetable crops such as runner beans, tomatoes and cucurbit crops (in that order of importance) are also grown, but of the district's total income the bananas still represent two-thirds.

Aftermath of the March, 1960, cyclone

Prior to the disastrous cyclone of March, 1960, the area planted to bananas was approximately 330 acres, and in the 12 months up to the date of the cyclone 85,600 cases (average weight 78 lb.) were produced. It is worth noting that the district's average production (almost 260 cases per acre) is approximately 100 cases per acre higher than that of the better districts of northern New South Wales.

All the bananas produced are transported to Perth for sale, but this market's requirement is actually only half supplied by the Carnarvon fruit. Severe competition on the Perth Metropolitan Markets is sustained from northern New South Wales, and generally speaking, the numbers imported exceed those of the Carnarvon product every year.

Banana sales are subject to considerable fluctuation, and over the past few years, average prices for top lines have varied from 1s. 8d. down to 8d. Needless to say, periods of over-production in northern New South Wales drastically affect the Carnarvon prices. (The total area in banana production in New South Wales at the present time is 33,000 acres approximately, compared with 11,000 in Queensland). Many Perth consumers believe (erroneously) that the imported bananas come from Queensland. In actual fact Queensland bananas rarely, if ever, find their way into this State.

Since irrigation is necessary in the Carnarvon area, production costs per acre are considerably higher than those in New South Wales., but the distance of the Eastern States plantations from the Perth market allows a more-than-healthy competition in favour of Carnarvon.

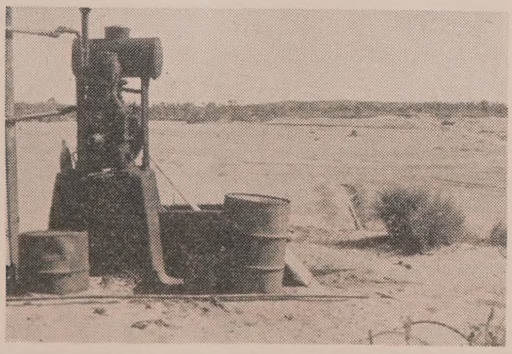
Many natural hazards have to be contended with by Carnarvon planters. Cyclones of varying intensity may be expected every four to five years; the 1960 cyclone registered an intensity of up to 120 m.p.h., this being the highest on record for the district, and was most unusual in that the "centre" passed directly over the area.

Gascoyne River Bridge during 1960 flood. Height of bridge above sand level, 25 feet

Droughts drastically affected the supply of irrigation water in the sands of the river, and this subject will be dealt with in a later section. Three floods have been experienced in the past 10 years, but generally speaking, although they cause inconvenience, they do more good than harm.

Two or three winter frosts each year are not unusual, but these do not constitute a major hazard.

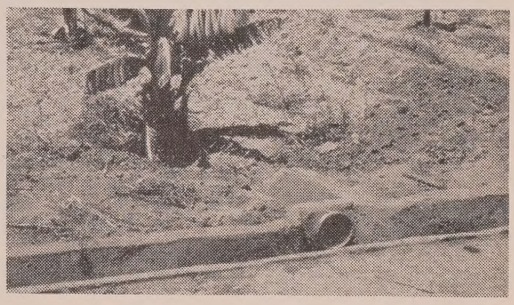
At the present time indications are that bananas will continue to be the most stable crop of the district for many years to come.



Typical river bank irrigation plant, pumping from surface sands

Plantation Layout.

The majority of plantations, as mentioned previously, have access to river frontage. However, approximately half of the quantity of water being utilised at the present moment is pumped from the river sands; and the remainder from bores and wells situated on the blocks themselves. Water is pumped from wells or bores by means of horizontal spindle centrifugal pumps of 2 to 4 inch outlet diameter, driven by diesel engines averaging 10 h.p.



Typical cement irrigation channel showing outlet and "stop"

From the bore or well, water is pumped through pipelines to each section to be irrigated. It is usually discharged into a spill-pool from which run a series of cement drains. From the drains the water can be flooded out into bays or directed into furrows, depending on the nature of the crop.

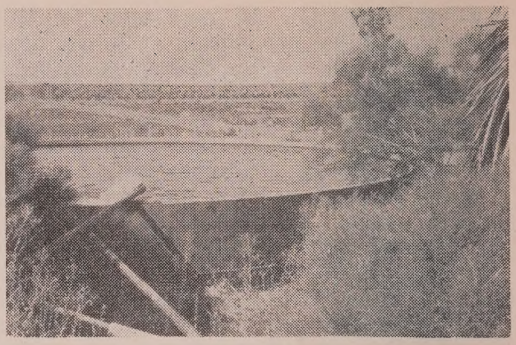
Fibrolite irrigation piping, showing support, outlet, clamp and "irrigator"

In recent years many growers have changed over to fibrolite piping, for although this is more expensive than cement drains, it is easily transportable and can be shifted from one site to another. After several years of use, even the best of cement drains develop cracks, and require constant attention. After six to eight years the average cement drain is ready for renewal.

An experimental irrigation system designed to reduce water usage. Each ¾ in. plastic hose irrigates three stools only, thus the entire bay is more rapidly filled, then hoses are easily dragged into the next bay. The pipe line is laid down the centre of the patch with the bays parallel to it

On some properties large irrigation tanks have been erected, some of them up to 150,000 gallons in capacity. The purpose of these is to increase the efficency of water usage during the dry period, for when only a small flow can be pumped it is used far more effectively if a big head of pressure can be built up before the final stage of irrigation takes place. If a trickle of water is pumped into bays or furrows, the time taken for the completion of the watering of large areas is far greater than it would be were a large flow used. This means that far more water is lost through seepage into the soil at the end nearest the outlet.

Many inefficient pumping units can still be found in the area. The level of the pump should be as close as possible to the level of the water, since as the suction head increases, the efficiency of the pump drops off extremely, and small defects in joints, packing glands, etc., very rapidly show up. On the delivery side, as few bends as possible should be used. Growers should remember that in a 3 in. line, a



Storage tank for irrigation water. An excellent aid to efficient watering

right angle bend in itself is equivalent to 7 in. of pressure head.

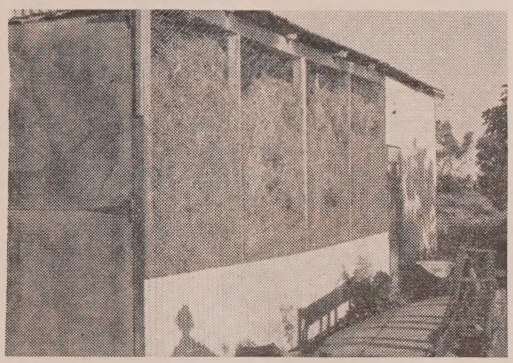
Some properties, due to their undulating nature, do not lend themselves easily to simple irrigation layouts. However, where possible, the grower should attempt to use a series of centralised channels to simplify his irrigation system.

An "earth channel" being used for irrigation of a young patch. Thousands of gallons of water are wasted in such channels

Although earth channels have been condemned for years by Agricultural Department representatives and growers

alike, many still exist. These can cost thousands of gallons of water in wastage each irrigation.

Channels should be arranged so that bays or furrows are moderately short. If practical, no bay or furrow should be longer than two chains. Beyond that length, wastage through seepage at the outlet end becomes an important factor, particularly as banana trash builds up.



Packing shed with spinifex walls and roof sprinklers

The packing shed is a very important feature of each plantation. If possible, it should be handily placed from the point of view both of access to the crops and access to the carrier. Wet weather still causes much inconvenience to both grower and carrier where packing sheds are badly placed. The nature of the shed itself is important, particularly with respect to the care of bananas after harvesting. Many sheds in the Gascoyne are entirely iron or asbestos built, with very little ventilation, so that on hot days they actually raise the pulp temperature of the cut fruit, thus enhancing its chance of break-down on the journey to Perth or in the ripening rooms. An excellent scheme is the inclusion of spinifex, straw, rush or trash walls, through which air can pass, and which on extremely hot days can be sprinkled from slotted piping, so that the temperature can be decreased. In some sheds of this nature a drop of 20 degrees on very hot days is not unusual.

Plenty of bench space is necessary in a packing shed, so that fruit does not have to be stacked too high on heavy packing days. Sufficient room should be allowed for the packed cases to be stacked well out of reach of the sun and within easy reach of the carrier.

Water.

As mentioned earlier, Carnarvon is situated in a semi-arid zone of relatively low rainfall. In some years rainfall can be completely discounted so that the success or failure of a plantation is dependent entirely on the quantity and quality of the water available for irrigation.

Most of the earlier settlers, their properties fronting the river, depended entirely on the water contained in the surface sands. This water has always been referred to as "top water," and its quality is usually very good. It is replenished completely whenever the river flows. However, there have been occasions in the past when, for up to four seasons, no river has flowed. The early settlers soon realised that in most parts of the river, top water alone was insufficient to see them through a long drought. Some bored through the first layer of clay beneath the top sands and struck lenses of sand below, many of which contained good supplies of excellent quality water. Also though, a salt bore would be encountered periodically.

For a time the area was favoured with good prices as well as with good and reliable water. At this stage, very few were involved in the industry; in fact, up till 1949 less than 50 were actively engaged in banana growing. The early 1950's brought a boom in land sales and a corresponding increase in land values. Bigger areas were opened by the Government for selection, and some of the larger freehold blocks were subdivided. As a result of this, in the present year 138 plantations are functioning, and of these 117 are growing bananas full time.

All this means a corresponding increase in the draw-off of water, both from the temporary top water system and the static "second water." These second waters are referred to by the engineers as "static" due to the fact that they are not completely replaced with each river flow. It seems that they were formed thousands of years ago as the river channels changed course. In each change of course a virtual pool of sand would be left, and this would be slowly covered by consecutive layers of clay and silt from following floods. With the advance of time, it can easily be seen how successive layers of sand and

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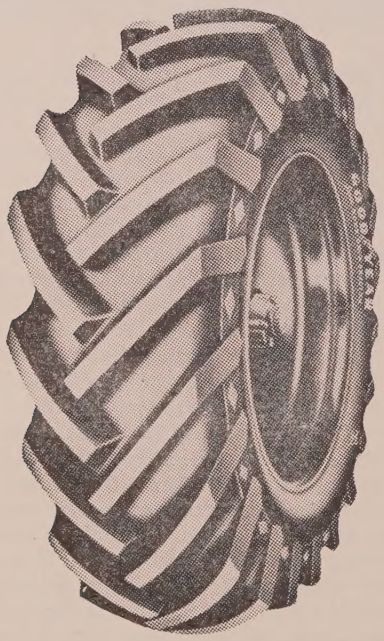

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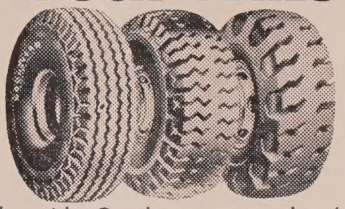

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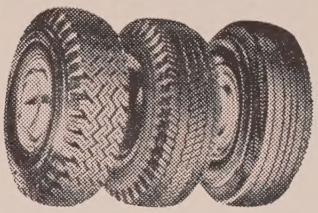

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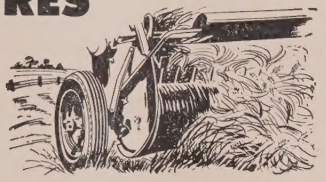

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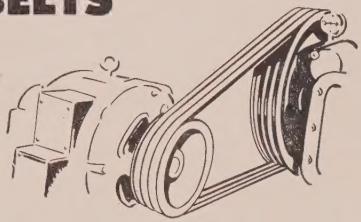

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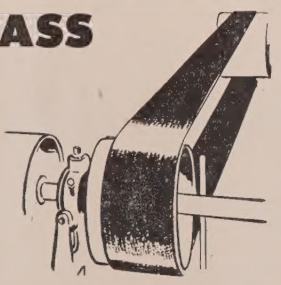

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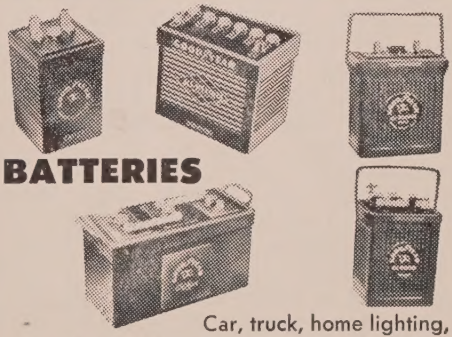

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clay have been formed beneath the delta area. It can also be understood, then, why the salinity of these second waters varies so greatly, not only in the quantity of salt contained therein, but in the chemical constitution of the salts themselves. Some, for instance, contain large quantities of gypsum (calcium sulphate); others magnesium sulphate, or perhaps even bicarbonates, which can be extremely injurious to crops.

It can also be seen why these lenses are not easily replenished by each running of the river; in fact, engineers have now established that within recent years the quantities of water contained in these have been steadily depleted, despite regular river flows, so that in 1959, the general second water levels were far lower than ever before, only nine months after the 1958 river had ceased flowing, despite the fact that most planters had carried on relatively easily during the 1951 drought.

Thus it can be seen that not only is water conservation and care in water usage essential, but also if the district's future is to be assured, some action on the part of the Government will be necessary to supply good quality waters to existing blocks. At the time of writing, a scheme has already been proposed, involving the utilisation of the large quantities of water contained in the sands beyond the Gascoyne River Bridge. Engineers have located deep, well-filled supplies here, and hope to pump from these through pipe lines to all points on both river banks.

Some growers have criticised this scheme, since they believe that these waters actually continue to flow down the river bed to replenish their own supplies. This is not the case. All of these waters are contained in basins and are static once river flow has ceased. It is hoped that they will be sufficient to adequately supply the area until a dam or dams are constructed.

Restrictions have been imposed by the Minister for Works, by means of which it is hoped to reduce the draw-off from the present systems and so carry on all properties for longer periods without stress in times of drought.

Shortage of water penalises the grower in two ways. Firstly, if the river is extremely low, as pointed out earlier, the pumping unit will not be able to operate to its maximum efficiency, since it will be working against an increased suction and pressure head. This means that more and more fuel is necessary to pump the required quantity of water. Also, the grower's time must be taken into account. In times of shortage the affected growers must spend a great deal of time working on their wells and pumping equipment, or perhaps even in search for further supplies.

The danger of rising salinity is a very real one. Water containing 60 grains of common salt (sodium chloride) per gallon is considered marginal both for bananas and beans. Some waters, in fact, although they are far lower than this in the salt content, may contain other salts such as bicarbonates, which will also prove injurious to plants. The danger of salt accumulations in the soil also becomes evident. It is often impossible to avoid increasing salinity when one is pumping from a block bore or second water, but it is suggested that it is far better to maintain a light draw from a number of points rather than pump large quantities from one point. As the lens subjected to heavy draw-off is depleted, the increasing influence of saline seepages can be expected very rapidly.

Throwing up the bank of a bay

Irrigation.

The normal means of banana irrigation in the Carnarvon district is by flooding. After levelling the area, a series of "bays" varying in width from 8 to 18 ft. are formed by the throwing up of banks. This is carried out with a mould-board

plough or "ditcher," (two opposed discs; see illustration). An opening from the cement channel is made into each bay, with a cement spoon-drain to prevent water erosion of the adjacent soil.

It is recommended that a fall of 1 inch per chain be incorporated into these bays, so that even after trash accumulation has occurred, irrigation can still be carried out easily. As pointed out earlier, excessive bay lengths brings about inefficiency of water usage; therefore, the recommended (optimum) length is two chains.

Polythene sheeting being used to reduce water usage. See also the weed growth outside the edges and the clean area covered by the sheeting

In the earlier years of banana growing in Carnarvon it was customary to plant into a series of furrows, which were later opened out into bays as the plants advanced in growth. This method was highly efficient in its water economy although it involved considerable work in the "opening out."

At the present time, banana irrigation practices are as follows: On heavy soils, such as those found in the south bank area, the crop is watered by the average planter at least once every week in summer (to a depth of 4 in. in the bay) and once every 10 to 14 days in winter, dependent on rainfall.

On the light soils of the north bank where far more rapid drainage occurs, twice weekly watering in summer is standard practice, and weekly watering in winter if the season is rainless and dry.

Although not always practicable, irrigation is most effective when carried out during the night, to reduce the evaporation percentage.

A water usage trial was conducted at the Gascoyne Research Station, and in the course of this, depths and frequencies of application were investigated. One section was watered to a depth of 4 in. at each irrigation, but was divided into three series of bays, one receiving this 4 in. twice per week in summer and once per week in winter, the second once per week in summer and once every 10 days in winter, and the third once every 10 days in summer and once every three weeks in winter.

In another section water was applied only at 1 in. depths with each irrigation. (This was done with a large number of outlet pipes through the centres of the bays.) Again this was divided into three parts, the first receiving four applications a week, the second three, and the third two—this being the summer schedule; the winter schedule was half this quantity.

The last section received water at varying depths—6 in., 4 in. and 2 in. Broadly, the result of the trial was as follows: It was found that the 4 in. application was equally advantageous as the 6 in. application, but with 2 in. applied with each irrigation the stand was somewhat poorer. Where 4 in. was applied every week in summer, the bananas ware equally as good as those in the area receiving 4 in. twice a week. It was noticed that although the 10 day section was somewhat slower to reach the "canopy" stage, once this had been reached the harvesting results were actually better than from any other section in the entire trial. Five bunches over 100 lb. in weight were harvested from these three rows alone. In the section receiving 1 in. applications, it was found that after canopy formation, two 1 in. applications per week in summer were equally as good as four 1 in. applications.

After the conclusion of this trial, the water situation in parts of the plantation area became very drastic in 1959, and many growers were forced by circumstances to reduce their frequencies of application. They found that even where waterings were spaced out to once every fortnight in summer, if the bananas were at the canopy stage they continued to produce as well as previously.

Thus it can be seen that if water economy is studied by the planter, his

pumping costs per acre will be substantially reduced, and if only a limited quantity of water is available a considerable area of bananas could still be maintained.

A trial is now in progress on a private property on the light soils of the north bank of the river, and in this a number of methods of irrigation and frequencies of application are being investigated.

The quality of irrigation water is extremely important. It is considered by this Department that a water containing over 60 grains of common salt per gallon is an extremely risky proposition for banana growing. Where a water has become saline (perhaps during a drought) and no other supply can be located, the depth of application should be increased and the frequency reduced. This method has been put into practice in previous years and found to be quite effective for carrying the plants on until better water is available. In the bay system of irrigation, very little salt accumulation occurs at the soil surface, but the average planter will notice some powdery accumulations occurring on the banks.

Planting.

When planting the grower must first decide which spacing system he intends to use. There are two orthodox spacings, and each has its purpose.

The "furrow" system of irrigating young bananas

The original "wide planting" system entails the planting of propagation material at 10 ft. centres—that is, bays are made up with banks 10 ft. apart, and the planting holes are dug 10 ft. apart in the bays. As the original parent plant becomes mature and suckers form around its base, three are left when gouging is carried out. These three then constitute the base number of pseudo stems on the area. It will be found that for the initial planting, 435 planting pieces per acre will be necessary, and after the first year, 1,305 stems will be the base number per acre.

The "wide planting" system, showing parent plants. Three "followers" will be left on each parent

The "close planting" system was designed by Mr. W. D. Marr, Tropical Adviser, 1949-53 and at the present moment a little over 50 per cent. of Carnarvon's regular banana growers have adopted it. Under this system, bays are formed with the banks 12 ft. apart, and the plants arranged on a zig-zag pattern 5 ft. apart inside the bays, with a distance of 7 ft. across the bank to the next row of plants. (See illustration.) One sucker only is left on each parent plant. Here the base number of stems per acre is 1,355, thus it can be seen that if the measurements are closely adhered to, there is very

Extreme "wide-planting"—A 9 ft. x 7 ft. carrying one sucker only

little difference in the light intensity between the fully-developed wide planted patch and the close-planted patch in which the one-sucker system has been followed.

The "close-planting" system. Newly planted suckers, showing double row in each bay

The advantages of the wide planting system are as follows:—

(1) A much smaller quantity of planting material is necessary and hence the total amount of labour involved is far less.

(2) Due to the higher light intensity in the earlier stages, the suckers develop very rapidly indeed, so that little, if any, time lag can be noticed in harvesting. That is, before all the parent bunches have been cut, the following bunches are already maturing.

(3) If the "trench" system is followed at planting, water usage in the earlier stages is reduced.

Disadvantages:

(1) Only 435 bunches can be harvested initially, and due to the greater exposure of the plants and the bunches, the initial bunch weight is not usually high.

(2) A large area of bay is being watered for a small number of parent bunches in the first year if the bay system is adopted from the outset.

(3) Since the plants take quite some time to form a canopy under this system, weed growth persists for far longer, making for greater labour involved.

The advantages of the close planting system are:

(1) A large number of bunches are harvested per unit of area from the initial planting, and since these have been protected by the closeness of the stems, the quality and weight are usually good.

(2) A far greater weight of fruit is harvested for the initial quantities of water applied, since it takes just as much water to produce 435 bunches under the wide planting system as it does to produce 1,355 under the close.

(3) Weeds are completely eliminated after approximately six months of active growth, since the canopy stage is reached quite early.

Disadvantages:

(1) A bad time lag occurs between the harvesting of the parent bunches and the harvesting of the first of the follower bunches. This is due to the fact that at an early stage the light intensity inside the patch is reduced, and with it the rate of sucker growth is decreased.

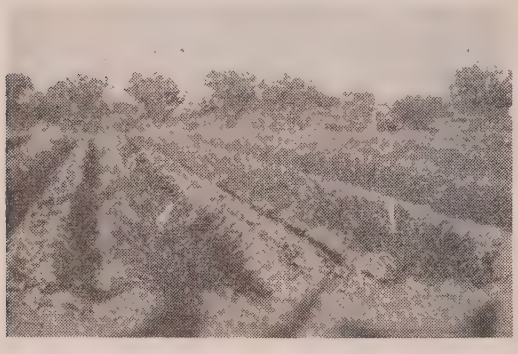
(2) Since the original parent crop is so even in its rates of growth (so that most of the bunches are thrown at once) a "burst" of production often occurs, and this can be a disadvantage from the economic viewpoint.

(3) Once again due to the even rate of growth, it will be found that the canopy formed by the parent plants reduces the light intensity far more than the canopy produced by the followers, since the rates of growth of the latter are much less even (first followers may be noticed in all stages of height and girth). Sometimes due to this low light intensity in the parent, close planted crop bunches fail to "fill" as they would if the light intensity were higher.

The major differences obviously only occur in the first two years of growth. Thereafter, the two methods are extremely similar. Each, of course, has its purposes.

If a grower wishes to have as large a sum of money as possible come in quickly from his banana crop, the close planting system offers the best avenue. If, however, he has the time to come somewhat more slowly into a production which is more regularly spaced over the first few years, he follows the orthodox wide planting system.

On certain sections of the river (particularly where light soils are encountered) patches often fail to carry on beyond the "first follower" bunch. (The probable reasons for this will be discussed later). Where this occurs, the close planting system is the only one which can be even considered.



Uncontrolled weeds drastically reduce banana growth. The banks have been disced but the plants in the bays are scarcely visible

Apart from these two orthodox systems, many other variations have been practised. Many growers have planted in rows 9 ft. apart with a distance of 7 ft. between the plants and 8 ft. x 8 ft. on a square leaving three followers on each. After the parent crop, these are far too close, and sucker growth is reduced. Also, bunches fail to fill as they should, and fruit quality becomes poorer, due to the lack of light intensity. One particular grower has in recent years practised a 9 ft. x 7 ft. planting, leaving only one follower on each parent. As a result, the bunch size of each following crop was far greater than in most other patches in the area, and the individual fruit quality has yet to be bettered. Perhaps the only disadvantage is the excessive size of the individual fruits. It was found that sucker growth was extremely rapid, so that bunches were produced within a shorter time than in the orthodox systems. Although fewer bunches are harvested from the parents than in the close planting system, a patch such as this will rapidly "catch up" on the first and second follower crops.

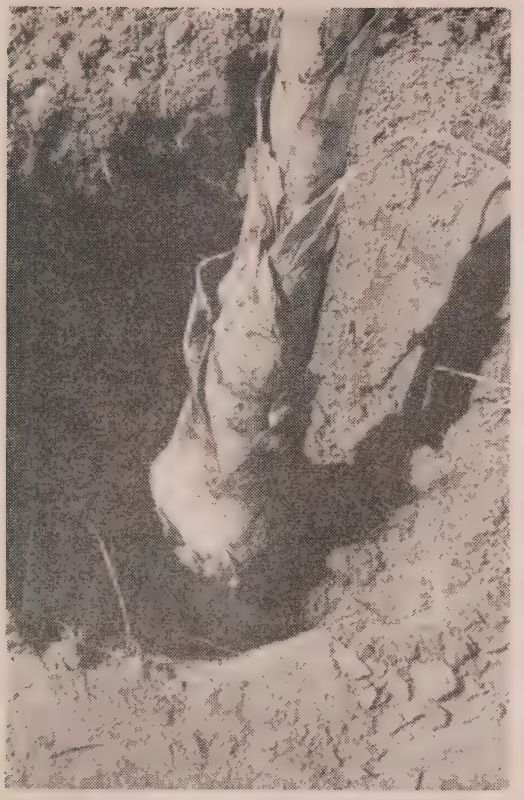
Some people have attempted to bring bananas even closer than the orthodox 5 ft. x 5 ft. x 7 ft. (close planting). Admittedly more bunches are obtained per acre, but sucker growth is so drastically reduced that no reduction in spacing can be advocated.

Having decided which system he intends to use, and having applied a preliminary watering, the grower then digs the planting holes, either by shovel or mechanical post-hole digger (a tractor attachment). These are sufficiently deep to allow for the planting material to be set into the ground to a depth of 15 in. to 20 in. Where the post-hole digger is used, particularly in soil which has a relatively high clay fraction, the grower should be sure to "break in" the sides of the hole before planting the banana, since through the action of the digger these sides are inclined to set so hard that often the soft banana roots have considerable difficulty in passing through them.

In past years it was common practice to put a small quantity of fertiliser into each hole, but this is no longer considered necessary by this Department.

Types of planting material vary widely, and each type has its particular advantages. Maiden butts or suckers are usually well suited to spring and early summer, or very late summer plantings. (A maiden butt is a very advanced sucker which has not, at the time of digging away from the original stem, produced a bunch). Butts, and pieces of butts with "eyes," or small suckers are best used throughout the hotter months of the planting season, as they are less inclined to rot.

Actually, when planting material is scarce, growers have been obliged to use material of all kinds, some of which, years ago, would have been considered as being of very poor quality. It must be remembered, however, that genetically, all planting material is exactly the same, since the domestic banana species are reproduced by vegetative means only. This has been proven in recent years, as a result of the close planting system being used on such a wide scale. Old and so-called "run-out" suckers, old sections of butts from pseudo



Planting a "spear-point" sucker

stems which have produced, and even what could almost be termed "water suckers" have been used in some of the larger patches, and yet at the time of harvesting no difference can be discerned, except where very advanced maiden butts have been planted. Here the bunches, although being produced far earlier, are usually much smaller due to the reduction in leaf area prior to the formation of the embryo bunch within the base of the pseudo stem.

It has always been considered poor practice to use suckers from a one-year old, or younger, plantation, as these are very inclined to rot (or "boil") in hot weather.

It is wise to dip all material to eliminate nematodes before planting. This will be discussed separately in a later section.

Planting material is obtained from old patches which have been or are being abandoned. It is normal practice to give the patch one irrigation to soften the soil just prior to removal of the material, then where possible a small hole is dug at the base of each pseudo stem on the side remote from the position of the old underground stem. The desuckering bar is then used to separate the standing stem from the old butt, and with leverage it is toppled in the direction of the hole. The purpose of the hole is to make this toppling easy and prevent damage to any small suckers which may be present. Suckers, if sufficiently advanced, may then be removed from the stem, and the butt may be cut off and if necessary, hacked into sections, each with an "eye" or small sucker. Cut surfaces should be allowed to dry (or cork) a little before planting.

Where suckers or maiden butts are used, the top of the stem is cut through so that all leaves are removed. This reduces the transpiration rate. On all planting material, all roots are "barbered" away; in fact, it has been found recently that sometimes even the outer "skins" of the butt or sucker can be peeled off almost like a potato skin. This reduces nematode infestation.

On the heavy soils of the south bank (and of the gullies on the north bank) it is advisable, after covering in the planting material, not to apply any irrigation water for several weeks. It will be found that moisture retained in these soils will be sufficient to encourage new roots to develop, and produce growth in whatever material happened to be used. If water is applied too soon, and hot days are encountered shortly afterwards (which is always a possibility) many misses will occur through "boiling." On the lighter soils, which dry out far more quickly, one watering can be applied immediately after planting, and then the patch can be left for a fortnight before further irrigations are made.

Banana planting is normally carried out from August to March inclusive, and as with planting material and spacing, there are advantages and disadvantages to the various planting times.

Early planting (August to December) usually gives an excellent "strike"; the plants are well advanced before the onset of winter, and thus better able to withstand the cold. However, bunches from such plantings are normally harvested when fruit is very plentiful—that is, in

the poorest marketing period, and it is found that the peak of production continues to coincide with this time.

Later planting usually brings peak harvesting into the winter shortage period, the advantages of which are obvious. However, planting in the hotter months often becomes a gamble, since many misses can occur. Also, the plants are still very small at the onset of winter, which means that they are more susceptible to cold weather damage and severe weed infestation.

Replacements are sometimes necessary if many of the planting pieces fail to "strike," and these should be planted at a very early stage if possible; otherwise they have little chance of producing if the remainder of the patch has decreased the light intensity of the environment.

Cover cropping trials have been carried out on private plantations with no beneficial results. Cover cropping amongst young bananas has been found less desirable than keeping bays clean of all growth other than the bananas themselves. However the intercropping of late season banana plantings with runner beans is recommended as a valuable practice. Added protection from wind and cold is afforded the young plants, and growth rate is increased.

Varieties.

In the Gascoyne area, only Cavendish bananas are planted. These are (1) the original Dwarf plant locally known as "Cavendish," and (2) a mutant from this, the Williams Hybrid or Golden Gros. The former have lost popularity in the Carnarvon district, despite the fact that the majority of them remain standing even after cyclones of high intensity. Their waning popularity is due to, firstly, the difficulty found in working amongst them —(the throats are often no higher than 5 ft.); secondly, they are extremely prone to cigar end rot and other secondary fruit damage brought about by the more compact nature of the arrangement of the hands which imprisons the bracts, preventing them from falling clear. Lastly they have a much greater tendency to "choke" when adverse growing conditions are encountered. This often means that as much loss can result after a cyclone in a "Cavendish" patch, even though it remains standing, as in a patch of Golden Gros which has been almost entirely flattened. They are most intolerant to cold conditions, and very often over 50 per cent of the plants will choke as a result of a cold winter.

It is worthy of note that in Queensland and Northern New South Wales a similar trend is taking place.

Wind Breaks.

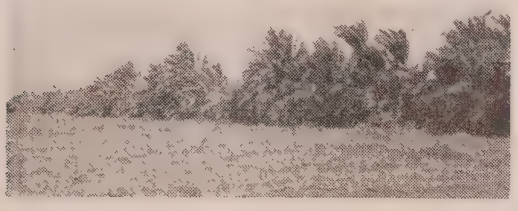
As mentioned earlier the district is subject to extremely strong winds in summer. As a result of these strong winds, either the outer two or three rows of bananas on the southern aspect of the patch must suffer heavily from their effect, or a suitable windbreak should be grown or erected to minimise the effect of these winds.

Windbreak of Pigeon Pea. Note asbestos irrigation pipe in the foreground

Many tree species have been tried by growers as permanent windbreaks. To name a few of these in order of importance, Athel Tamarisk, River Gum, Mangoes, Dates, and Tecomas. Other live windbreaks of a more temporary nature have been used in recent years are Plantains, Bamboos and Pidgeon Pea.

A number of windbreaks have been tested at the Research Station, so that recommendations could be eventually standardised. Tamarisks, gum trees, tecomas, macadamia nuts, thevetias, pidgeon pea and sugar bananas have all been tested. Several obvious disadvantages have been noticed in the tamarisk and gum tree breaks. Firstly, when in close proximity to the banana patch these have a tendency to cause very strong winds to eddy on the lee side during cyclones, and this effect is just as disastrous to a stand of bananas as a direct blast. Also,

it was found that the tamarisks under certain conditions will rapidly accumulate salt in the leaves, and this salt is later spread around the surface of the soil in the near vicinity of the tree as dead leaves fall, and rain drops or heavy dew cause the leaves to drip.



Date Palm windbreak

Two other drawbacks to the tall-tree windbreaks which may cause damage to plantations are (1) the excessive shade produced, and (2) the enormous root spread throughout the damp banana patch. Tamarisk roots have been ploughed up 150 ft. from the nearest windbreak on occasions.

Plantain and lady finger banana windbreaks are unfortunately not regularly attended by growers, so that ripening bunches may often be found on them. Needless to say, this promotes an increase in fruit fly numbers. These plants also are susceptible to Panama disease, one of the most serious diseases of bananas in other countries. For these reasons windbreaks of this type are no longer recommended.

The Yellow Tecoma (*Tecoma smithii*) is considered an excellent windbreak for three reasons: firstly, it grows rapidly to its maximum height; secondly, it does not grow into a tall tree but remains at approximately the same height as the banana crop, and thirdly, it has to date shown no tendency to compete in any way with the bananas. It forms quite dense foliage, and in spring produces most attractive yellow bell-shaped flowers. It is easily grown from seed.

Pidgeon Peas are also most useful but, unfortunately, do not last much longer than two years. Little trial has been given on private plantations up to the present time to permanent windbreaks such as dates, macadamias, olives, etc., but all of these have possibilities. Bamboos and artificial windbreaks built of gidgee poles, wires and trash (which is later overgrown with a creeper) were used extensively some years ago, but are now rarely found since, in the case of the former, it is found that the bamboos compete too heavily with the crop, and that the latter rapidly become unkempt and difficult to maintain. They also harbour vermin.

Nematodes.

Recent investigations have shown that in the Carnarvon area, nematodes or eelworms seriously limit the production of bananas and are probably the most important pest of this crop.

Damage from this pest was first suspected some years ago when it became obvious that banana patches, particularly on the lighter soil types, were prematurely "fading out" after the production of the maiden bunch; and when an increasing number of abject failures resulted from replanting on old banana ground.

Plant pathological examination showed that banana roots grown under these conditions were heavily infested with nematodes of several different species. Some species, e.g., root knot, cause obvious root galls or swelling, while others, e.g., *Radopholus*, rot the roots and penetrate the underground stem giving rise to the condition known locally as black rot.

When the first control trials were initiated, fumigant materials were limited to D-D and E.D.B. compounds which had to be applied at least three weeks before planting by drip feeding into the plough furrow. It was also necessary to disinfect the planting material, and organic phosphate insecticides were used for this purpose.

In 1958 the Government Plant Pathologist obtained test quantities of a new water miscible fumigant composed of 1, 2 dibromo 3 chloropropane. A number of "spot trials" were commenced at Carnarvon on private plantations which had been previously affected by nematodes. After six months it was obvious that great benefit had been obtained, improvements being noticeable in several respects. The treated stools continued to produce healthy suckers which, in turn, produced healthy plants, instead of falling away drastically in vigour during the winter and then failing completely. The bunches produced

from these following suckers were often even better than those of the parents. Thirdly, the new suckers themselves, when dug up, were found to have clean white root systems with abundant fibre root, and clean healthy butts completely devoid of any black rot.

This water miscible fumigant is now advocated by this Department for regular use by planters. It should be applied during the warm months of the year (the first application preferably in spring) and the treatment repeated at least every 12 months. Its application is extremely simple. On young patches (up to two years old) a rate of one gallon per acre is normally advocated; for older patches, the two-gallon rate is recommended. After the quantity to be applied to each bay has been worked out on a per-acre basis, the fumigant is bulked up with water in an open top four-gallon tin, into which a petrol tap has been soldered. This tin is set up over the cement channel and the rate of flow of fumigant from the petrol tap is regulated as closely as possible so that the tin is emptied as the bay is completely filled. This means that the fumigant has been evenly dispersed throughout the entire flooded surface, and can penetrate to all the plant roots.

Just prior to the disastrous cyclone in March, Carnarvon's banana crop was looking its best ever, partly due to the widespread application of this fumigant. Since the cyclone, most of the patches which were previously treated are now making excellent recovery. It is believed that, with regular eelworm control practised on the plantation, the productivity per acre should rise by at least 25 per cent., and the life of the plantation will be extended very considerably.

Weeding.

To get the maximum first bunch production from a banana patch it should be kept free from weeds from the outset. Most weeds can compete far too vigorously with the soft and flabby-rooted bananas, and if allowed to run riot will retard them so badly that often they need to be replanted.

The easiest way to control weeds is to prevent them from ever reaching any size. Normally, chipping hoes are used to keep weeds down, although in wide planted patches the use of rotary hoes is also possible. (The use of the latter is not advised in summer, when the roots of the plants have come up almost to the soil surface, but in winter, when a semi-dormancy occurs, its use is often beneficial.)

In the Eastern States, weed control with arsenical weedicides is often practised, but this is not advocated for Carnarvon conditions due to the possible residual effects on following crops. The use of some of the newer weedicides is being investigated but it is still believed that to obtain the best results from the plants, regular control with the hoe until canopy formation, is still the most effective. After canopy formation, weeds no longer survive, due to the excessive shade.

Fertilisers.

For many years it has been believed by growers that since the banana plant is large and its growth is rapid, it must require large quantities of fertiliser, and this is reasonable to assume. No standard practice has been advocated, but most growers have usually applied one or more of the animal fertilisers such as blood and bone, whale meal, whale solubles, and some of the inorganics (super, sulphate of ammonia and sulphate of potash.)

The rates and times of application have varied from plantation to plantation, but one point has always been obvious: fertilisers have been one of the main items of expenditure on plantations. They would certainly constitute one of the major costs of production per acre.

A trial was initiated at Gascoyne Research Station in 1952, to investigate the main fertiliser constituents necessary for banana growth. Nitrogen, phosphate, and potash were applied to test rows singly and in their various combinations. Buffer rows and control rows were also incorporated. Up to the time that the patch was destroyed by the March cyclone, no difference in bunch weights had been recorded. That is, over the entire period, no benefit at all had been obtained from the use of fertiliser of any kind. In the last year of life of the patch, however, it was noticed that rows receiving nitrogen and potash together were slightly greener and the plants had a slightly greater girth measurement than those in the remainder of the patch. This was not transmitted to fruit weights.

These results seem extraordinary, and in fact are disbelieved by some banana growers. However, when the banana analyses are studied the reasons become a little more obvious. Principally, banana plants contain water and cellulose. There is relatively little nitrogen and practically no phosphate in any part (including fruit), and although eight times as much potash as nitrogen is present, this figure on a weight-per-acre basis is still extremely low.

Assessing just how much of each fertiliser constituent will leave the banana patch each year, fruit analyses must be considered. Typical analyses of Carnarvon fruit are as follows:—

Samples :	1		2		3		4	
	Skin	Flesh	Skin	Flesh	Skin	Flesh	Skin	Flesh
Weight (grams)	400	632	397	708	338	637	389	651
Moisture %	90·8	75·4	89·7	76·6	90·7	78·0	90·7	76·3
Reducing Sugars % (as dextrose)	1·9	14·9	2·3	17·0	1·7	16·4	1·8	15·8
Starch %	1·0	7·9	0·4	6·3	0·4	7·2	0·9	8·4
				Parts per million				
Nitrogen, N	1110	Nil	1140	Nil	1340	Nil	1100	7
Potassium, K	8300	4400	8500	4250	9200	4100	8100	4150
Calcium, Ca	393	75	452	89	325	56	348	70
Magnesium, Mg	149	435	178	419	132	379	141	425
Phosphate, P	303	240	324	270	291	219	280	263

This would represent 100 lb. of sulphate of ammonia, 500 lb. of sulphate of potash and 50 lb. of super, which must actually be replaced each year; a very small quantity by comparison with that normally applied by the average planter.

Recently a small number of planters had their fertiliser programmes on this basis, and experimentally applied little or none from the outset. To date no difference can be seen between plants receiving fertiliser and those which have been completely untreated.

A good healthy root system and good quality water are the two most important factors in banana production.

A number of well-mixed balanced concentrated fertilisers are now available, and a light dressing of such as these once or twice per year is advocated as a precautionary measure to cover replacement in the soil. Fortunately, Carnarvon's soils are inherently very fertile.

In some cases excellent response has been obtained to the application of sheep manure at extremely heavy rates. This is most probably due to the effect on the soil's structure, since weathered sheep manure actually contains very little of manurial benefit.

The effect of the various fertiliser constituents on fruit quality has been thoroughly investigated at the research station, and also in Perth with the co-operation of the Research Branch. No concrete results were obtained, since any variations were only slight.

During hot weather, though, there were indications that excesses of nitrogen fertiliser are deleterious, and can induce premature breakdown.

Desuckering.

As the plant advances in growth, suckers are formed around its base in the manner typical of all plants of this order. Surplus suckers must be removed so that the light intensity in the patch will not be excessively lowered, and so that individual stems will remain vigorous and produce large bunches. It is false economy to leave too many "followers" in a patch, as bunch size and rates of sucker growth are drastically diminished.

As mentioned previously, under the wide planting system three suckers are left on the original parent stem in the first year. Thereafter, one sucker only is left on each stem. Under the close planting system, one sucker per stem is left from the outset.

Under Gascoyne conditions, desuckering is normally carried out with a gouge. A simple but effective gouge is easily made from the main leaf of a car spring. This is straightened and cut to a length of approximately three feet leaving the shackle loop on one end to serve as an

aperture for the handle. The cut end is then drawn to a point and made slightly concave. (See illustration). A short piece of wood passed through the shackle loop serves as a handle. This implement is used by thrusting the point down between the sucker and the main stem, then rotating the handle so that a cone-like cut is made into the heart of the sucker. By this means it is completely detached, and can be pulled out and discarded.

When selecting the sucker or suckers to be left on the parent plant, it is wise to take into account positioning as well as size and vigour of the suckers themselves. If the wide planting system is being used, three suckers should be left as nearly equidistant from each other as possible. In the close planting system, an attempt should be made to keep all the suckers "heading in the same direction," this always being along the rows, not towards the bank or the centre of the bay. Sometimes this is not possible but it should be accepted as a general rule.

Concerning individual suckers themselves, those selected to be left on the parent should not be too close to the butt, since as they grow they will be constricted for room. The closeness of the parent also usually indicates that the sucker has come from a shallow depth, which is undesirable. Ill-shaped or off-type suckers such as so-called "water shoots" should be removed in any case.

Several other systems of desuckering are now being used on the Gascoyne. Some growers constantly keep unwanted suckers cut back to ground level, while others crush those which are newly emerging with the heel. Neither of these methods are recommended, as they are not sufficiently permanent. Due to its simplicity and speed of working, desuckering with a petroleum product is being used quite extensively. The unwanted sucker is cut off almost at ground level, and a small recess is made into the top with the point of the knife. A teaspoonful of kerosene, petrol or distillate is then squirted in with an oil-can or tipped in from a bottle. Some growers claim big successes with this method, whilst others have abandoned it and gone back to the gouge because they have found that too many survive the treatment.

Trashing.

As each individual pseudo stem progresses towards maturity and bunch production, the older outermost leaves die back. These are removed for two reasons: firstly, when hanging in quantity they can reduce the light intensity around the base of the plant and retard sucker production and growth, and secondly, the dead leaves can often damage young fruit between flowering and the time the fruit is harvested. Wind movement in the patch is often responsible for the scraping of a dead leaf over several hands of fruit, causing severe blemishing.

Trashing is the removal of these dead leaves by cutting off back to the live portion of the leaf sheath. Sometimes the entire sheath is dead, in which case it is cut off at the base of the pseudo stem. As they are removed, these leaves are usually heaped into the centre of the bay, where they progressively rot away with the constant watering and the action of fungi and bacteria. Usually, many earth worms may be found amongst the rotting trash, and in summer, if the bananas are in healthy condition, many of the young roots may also be found there in quantity. When trashing it is wise to keep dead leaves and stems away from at least one of the banks so that water flow is not impeded during irrigation. Drastic water wastage results from a big build-up of trash through which no channel has been left.

Bunch Covering.

In northern New South Wales banana growing districts, it is considered good policy during winter to cover maturing bunches with plastic "aprons." This sometimes results in a 10 per cent. increase in bunch weight, and far less bunch marking and damage. Trials were carried out by the Department of Agriculture at Carnarvon, and increases in weight of up to 5 per cent. were obtained under winter conditions, but due to the cost of the plastic bags at the time, it was extremely doubtful if covering was justified economically. It is noteworthy that fruit which had been covered was far cleaner and had much better "bloom" than that from control rows.

Pests and Diseases.

Nematodes have to-date been Carnarvon's most important economic pests, and these have been dealt with in an earlier section.

The Gascoyne settlement is well removed from other commercial banana growing areas. From the inception of the industry at Carnarvon strict quarantine measures have been adopted to minimise the chances of infestation by the many diseases which can affect the crop.

So far these have been very effective and the district has remained largely free from serious disease problems.

Harvesting.

It is very difficult to lay down any well defined rules for judging the maturity of the bunch which is ready for harvesting. Each planter will finally be able to judge, from constant experience, just how long his fruit will "hang" without becoming too full and prone to ripening in transit or breakdown. There are several good guides which could be useful to the inexperienced grower, however. The first is the appearance of the leaves of the plant. If very few healthy leaves remain on the pseudo stem, the bunch will rarely fill to any greater extent than it already has done. Secondly, if the "tassel" (which consists of a mass of bracts enclosing the male florets) has died off, the bunch is usually ready to be cut, and thirdly, when

Record bunch on scales. Standard banana case for comparison

Record bunch—just prior to 1960 cyclone

the stigma (the last remaining portion of the female floret at the end of the banana itself) has completely dried off and shows no tendency to bleed when broken off, this also is considered a guide to maturity. The appearance of the fruit will finally be the main criterion upon which the planter will judge his harvesting, and as pointed out earlier, the development of this judgment will come with experience.

It is considered that to allow fruit to fill to its absolute maximum in the hot months of the year is unwise, as it leaves fruit very prone to premature breakdown after ripening. This is one factor which is blamed for the poor quality claims made against Carnarvon fruit in the Perth shops and markets. It must be remembered that New South Wales fruit being sent to W.A. is cut at the "full three-quarter" stage.

An article on fruit quality, packing and waxing appeared in the January, 1960, issue of this Journal.

Bunches harvested from record patch

Bunches are usually cut with a long bladed knife, and then the entire pseudo stem is also cut back and thrown amongst the trash. Some growers then chop it into short lengths, which assists it to break down more rapidly. The cut bunch is stood carefully against the nearest bank. When the grower has been through the entire patch, he carries out the bunches to a waiting vehicle (truck, utility, trailer, tractor and trailer, etc.).

Great care should then be exercised in the placing of the bunches on this vehicle. They are best transported "upside down," that is, with the tassel end uppermost, so that the bottom hands are not damaged. Where any bunch has to be leaned against the side of the vehicle, bags should be hung. Bunches should never be laid on their sides as extreme bruising will result. This may not be obvious while the fruit is being dehanded and packed, but will later show up after ripening on the market floor.

Yields and Duration of Plantings.

As pointed out in an earlier section, Carnarvon's average banana yield per acre is higher than that in northern New South Wales or Queensland. In the truly tropical countries where most of the world's bananas are grown, yields are low

Record banana patch—just prior to 1960 cyclone

by comparison with such areas as the Canary Islands and other countries where irrigation and more intensive cultivation is practised. In Central America and West Africa, for example, anything over 10 tons per acre per year (280 cases) is regarded as exceptionally good. In the Canaries, production has reached 19 tons (or 530 Carnarvon cases). But at Carnarvon, maximum yields have gone far higher than this. From a patch at Rokich Bros. plantation, over 1,000 cases per acre were produced in the nine months prior to the cyclone in March 1960. Two days after the cyclone, a bunch weighing 144 lb. was taken from the wreckage.

Carnarvon's annual average per acre can certainly be lifted by means of regular soil fumigation, weed control, and more care per acre. If an individual grower can exceed 1,000 cases, the district average could surely be raised to 500.

In recent years, the productive life of each banana planting has been reduced by nematode infestation on most areas of the Gascoyne. However, some of the older growers who have been relatively unaffected by this pest, held patches for 9 years up to the time of the cyclone. Over the next decade it is quite possible that retention of patches will be possible on most properties where fumigation is practised.

It is advocated that a small area of bananas be planted each season, so that in the event of a cyclone, the oldest section may be abandoned.

In some banana growing areas (i.e., parts of India), patches up to 100 years of age are not uncommon. This is achieved by judicious sucker positioning, and the complete removal of rotting butts, which are sometimes replaced with soil.

Transport.

All Carnarvon's primary products are transported to the Metropolitan Markets, in Perth, by the Gascoyne Trading Company, a subsidiary of Westralian Farmers' Co-operative. This Company operates a fleet of large, fast and modern diesel trucks, specially designed for the haulage of perishable produce under hot conditions. The metal sides of each body are fluted to allow the passage of air around bags and crates; and the front panel is entirely lowered, once again for ventilation purposes.

Transport specially adapted for banana haulage

The trucks reach Perth after only 22 hours of travel, and since most of the highway is now bituminised, delays are most infrequent.

The company also maintains a staff of mechanics to cope with repairs, regular servicing, and breakdowns. Over the last three years these transports have never missed a market, which is a tribute to the efficiency of the organisation.

Freight rates for the cartage of primary produce from Carnarvon to Perth are surprisingly low, bananas 11s. 6d. per case, beans 5s. 1d. per bag (approximately 1⅜d. per lb.).

Loading bananas into specially designed overland freighter. Such modern transportation has allowed Carnarvon growers to compete more than favourably with the New South Wales planters

The banana crates are carefully loaded and offloaded along rollers, and no "break" in the journey occurs (as was the case some years ago, when both road and rail were used, necessitating extra handling).

Several tests with cardboard cartons have been carried out, but to-date no carton has been satisfactory for banana

transport. Firms manufacturing cartons, however, will quite probably produce a satisfactory container within the next few years, and this will further facilitate handling.

Prospects of the Industry.

Although a very few years ago the prospects of the Carnarvon banana industry seemed anything but bright, in view of falling productivity, shorter duration of patches, and the severity of New South Wales competition, it now seems safe to predict that its best years lie ahead, for the following reasons:—

(1) The simple and effective control of eelworm through the application of water-miscible nematicides, giving the plant a clean root system each season, and increasing the productive life of a patch as well as its production per acre.

(2) The probability of increased supplies of irrigation water becoming available.

(3) The increase in efficiency of water usage by the average grower, reducing costs per acre (this is assisted by fumigation, which, in cleansing the root system allows more efficient water uptake by the plant from the soil).

(4) Through better packing, and waxing, a higher price for Carnarvon bananas can be maintained above that of the New South Wales article (which must be transported over greater distances).

(5) The opportunity to insure a banana crop in Carnarvon. Previously, no insurance company would take such a risk, but a scheme has now been formulated involving contribution by the Government and grower subscription by levy. This will give far greater security from impoverishment by cyclone.

(6) The constant improvement in the North-West highway, which will shortly be entirely bituminised. This will enhance the ability of the transport company to operate at lower costs.

For these reasons, it is quite possible that within the next five years, Carnarvon's expanding banana production could completely satisfy the Perth market's requirements (which, with increasing population, would be 160,000 cases annually —compared with 86,000 from Carnarvon in the 12 months up to the time of the cyclone).

This Department has an Agricultural Adviser stationed permanently at Carnarvon, and growers are reminded that much expense and trouble may often be avoided by discussing their banana problems with him.

ACKNOWLEDGMENTS

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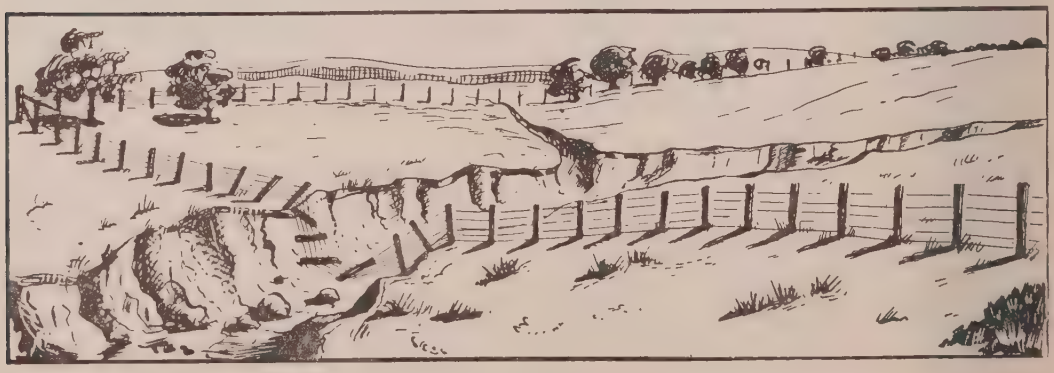

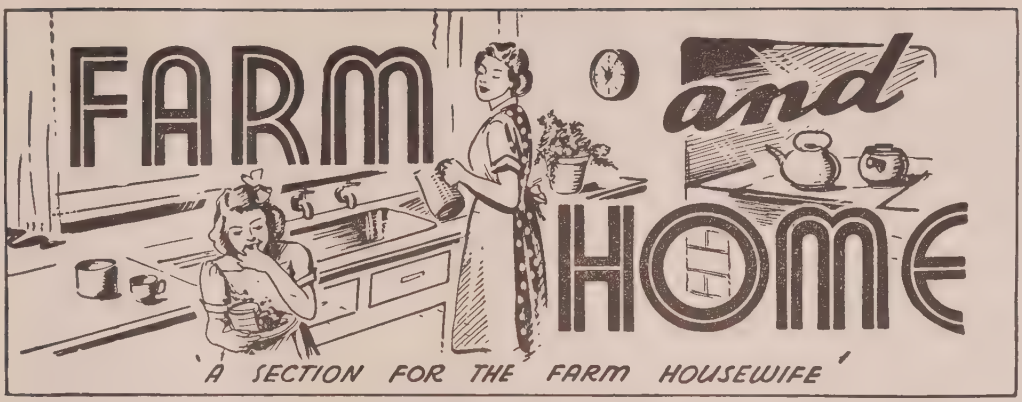

The Cornish Pasty

By HELEN M. GLOSTER

"Pastry rolled out like a plate,
Piled with turmut, tates and mate,
Doubled up and baked like fate,
That's a Cornish Pasty".

If the average Australian woman was was asked for a description of a Cornish pasty, her answer would tally fairly accurately with the above lines.

Australians are meat eaters, and the pasty, as made in Australia, is invariably filled with a mixture of meat and vegetables.

The Cornish pasty was evolved to fulfil a definite purpose.

One filled with meat and vegetables is a complete meal in itself.

Over the centuries Cornishmen have carried their pasties to work, down the tin mines, into the fields, out to sea in fishing boats. The qualities of a good pasty were such that it had to be sustaining, tasty, and nourishing. In addition it had to be capable of travel.

Any Cornishman will tell you that the test of a good pasty is to drop it down the shaft of a tin mine! A Cornish pasty not only has to withstand rough handling, but was subjected to the moist atmosphere in mines and on fishing boats.

While we like our pasties to be sufficiently firm for packed lunches for taking to school and to picnics, I doubt if any "Farm and Home" readers would be proud of a pasty which would survive the Cornish miners' test.

The foundation of the pasty as we know it today is *Short Pastry.*

Any firm cold fat may be used, butter, lard, margarine, good beef dripping, or a mixture of any of these. If you wish to make a good *hard* pasty and try the test use mutton dripping. This however is *not* recommended. (Beef dripping makes better pastry.)

SHORT PASTRY

Ingredients.

½ lb. plain flour.
¼ lb. fat (cold and firm).
Salt.
Water.
Squeeze of lemon juice.

Method:

Sift flour and salt.

Add fat, and rub into flour, with *tips* of fingers until mixture resembles hard, fine breadcrumbs.

Mix to a stiff dough with *cold* water.

Turn on to a cold slab or board.

Roll out and cut as required.

Bake in a *hot* oven.

Temperature 400° F.

N.B.—A little lemon juice added to water improves any pastry particularly that which is made with dripping. Short pastry for pasties should be as stiff as possible.

If cut with a six-inch plate this is only sufficient pastry for two pasties.

The modern pasty is cut to the size of a saucer, and this quantity will make five or six pasties according to the size of the saucer.

CORNISH PASTIES

Method:

Prepare the fillings.

Make pastry and roll out ¼ in. thick.

Cut into rounds the size of a saucer, place filling in the centre of each.

Damp the edges; there should be sufficient moisture seeping from the filling to do this.

Bring edges together, pinch and crimp* or frill.

Prick or make a small hole on top of each pasty. (This prevents bursting.)

Glaze with beaten egg or egg and milk for savoury pasties.

Bake in a hot oven for 15 minutes, then a cooler oven for a further 15 minutes.

Oven temperatures: Hot oven 400° F. Cooler oven 300-325° F.

* *To Crimp Edges.* Press edges together with left hand and fold over with right hand to form a rope-like effect on the *side* of the pasty. Avoid crimping on top of the pasty as tips are liable to get too brown.

In Western Australia the custom is to pinch a frill along the sealed edges.

Varieties in Fillings.

6 oz. topside steak (uncooked).
1 potato.
1 onion.
A piece of turnip (according to taste).
½ teaspoon salt.
Pepper.

Method:

Wash and peel potato and onion, cut into dice.

Cut meat into small pieces, removing any fat or gristle.

Mix ingredients together with salt and pepper.

Parsley Pasty.

Use finely cut mutton or lamb. Add chopped parsley, salt and pepper.

Rabbit Pasty.

Use the fleshy part of rabbit cut up into small pieces.

Add pepper and salt.

Chicken Pasty.

As above, using chicken.

Pork Pasty.

Fresh pork.
Potato.
Onion.
Sage or thyme.
Pepper and salt.

Eggy Pasty.

Bacon cut into dice, parsley and one or two eggs (now see Herby Pasty).

Herby Pasty.

Bacon cut in small pieces.
Parsley chopped.
Shallots (young) chopped.
Small quantity spinach, broken or chopped.
1 egg.

Method:

Pour boiling water over parsley and spinach. Leave half an hour then squeeze all moisture out.

Mix bacon, parsley, spinach, shallots and fill pasty, leaving a small opening for egg to be added. Crack egg and slip into the hole without breaking.

Finish crimping, and bake.

Apple Pasty.

Peel and slice apples thinly.

Sprinkle with brown sugar.

In summer, blackberries or mulberries may be mixed with apples.

Broccoli Pasty.

Boil broccoli (of cauliflower) until *nearly* cooked but still quite firm.

Strain, add salt. Fill pasty.

Date Pasty.

Stone dates and fill.

N.B.—A little lemon juice with dates takes off some of the sweetness.

Jam Pasty.

These are made smaller than the savoury pasties.

Any jam may be used.

This is a good way to use up left over pieces of pastry, and left over jam when bottle is almost empty.

Rice Pasty.

Use rice cooked in milk and sweetened to taste.

Mix with an egg and fill pasty.

Windy Pasty.

Prepare an unfilled pasty and bake.

While still hot, open out flat and fill each side with jam.

Australian Pasty.

Perhaps some reader would like to experiment and make a pasty with a truly Australian flavour.

A suggested filling is a mixture of kangaroo steak and pork, minced and well seasoned.

Kangaroo is a strongly flavoured meat and needs to be blended with other flavours.

Pork or bacon mixed with kangaroo make a good mixture.

Carrot, onion, turnip and celery are all suitable vegetables.

Parsley, mace, bay leaf, cloves, salt, pepper, a squeeze of lemon juice, any of these could be added to the filling for flavouring.

DREAM TRACTOR FOR FARMERS

Detroit, Michigan, USA (IFAP)—A "Dream" tractor has been designed by a U.S. manufacturer.

It is slightly less than half normal size and has all the comforts of a modern American home. The Ford Motor Co. has produced a model tractor which has a two-way telephone so the farmer can keep in touch with the barn or the house. It has weather forecasting equipment in the cab. It has heating, air-conditioning and a radio speaker.

Hydraulic power is used to turn all four wheels independently, to adjust the distance between the wheels and to increase the clearance under the tractor.

Power and implement controls are started by toggle switches and hand controls on both sides of the operator and the tractor is steered by means of two foot pedals, eliminating the need for either a steering wheel or stick. A television srceen mounted just above the windshield enables the operator to see the action of rear-mounted implements which are attached through an electrically-operated hitch, hooked up magnetically.

The weatherproof cab of the farm tractor is equipped with a food warmer, a coffee maker and a refrigerator. Drawers and a sink are installed behind the drivers seat.

The free-standing contoured swivel seat, with flow-through air inserts, can be moved in any direction and tilted to permit the driver to maintain an upright position even when the tractor is working a slope.

The manufacturer, however, has decided not to market this "dream" tractor just now. The company says it is only a model of what the farmer will have in the future.

METTERS

Tempered by Special New Oil Process which ensures extra long life

CULTIVATOR POINTS

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Avondale Research Station

FIGURE 1

First wheat crop taken after sub clover ley on medium-textured soil which has had periodic cereal crops since the original planting of sub clover many years ago. The centre plot received no nitrogenous fertilizer. Plots on the left and right each received sulphate of ammonia at 600 lb/ac. Despite the very marked increase in growth and green colour of the crop with nitrogen, there was no increase in grain yield. Grain protein was, however, increased from 11% to 14%.

The use of NITROGENOUS FERTILISERS FOR CEREAL GRAIN PRODUCTION In Western Australia

By W. J. TOMS, B.Sc. (Agric.), Research Officer, and G. H. BURVILL, M.Ag.Sc., Superintendent, Plant Research Division

NITROGENOUS fertilisers have so far been little used in Western Australia for wheat, oats and barley grown for grain. However, profitable results can follow their use under some conditions. Farmers who have seen field experiments are now interested in the use of nitrogenous fertilisers. Further interest will be stimulated by recent reductions in price. This article answers common questions asked by farmers about nitrogenous fertilisers for cereals. It is based on over 100 experiments conducted by the Department of Agriculture during the past 30 years.

WHAT CONDITIONS INFLUENCE THE EFFECT OF NITROGENOUS FERTILISERS?

Two factors mainly determine the response of grain yield to fertilisers supplying nitrogen. These are:—

(a) The amount of available soil nitrogen present.
(b) The weather during the growing period.

Soil Nitrogen.

Soils which can provide high levels of available nitrogen will not give economic increases in grain yield from the use of nitrogenous fertiliser. In this class are the "heavy" soils of the central and eastern wheatbelt that have not been overcropped, and soils that have grown good stands of subterranean clover (*Trifolium subterraneum*) prior to cropping. However, even on such fertile soils the application of fertiliser nitrogen will nearly always give an improvement in leaf colour, and an increase in plant growth and protein content of the grain. (See Fig. 1). Yet because soil moisture is deficient in spring the increases in leaf growth are not reflected in increased grain yield. The protein content of the grain is increased, but this is not important to farmers when payment is not made on a quality basis.

Increased grain yield with nitrogenous fertiliser is often obtained on previously infertile soils that have been improved by subclover, but the increase in yield is often too small to be payable.

Newly cleared "light" land is most likely to give increased yield with nitrogenous fertiliser (see Fig. 2). Even though it lies bare fallowed for six to nine months it is still deficient in available nitrogen. On such land the better crop growth obtained enables better stubble fires and hence better control of poison plants and other scrub regrowth.

Increases in grain yield can also be expected on soils of medium texture which have been reduced in soil nitrogen by intensive cropping.

For all soils, if a second or third successive crop is taken, a payable response to nitrogenous fertiliser is more likely than on the first crop, particularly if the stubbles of the preceding crop are ploughed in (see Figs. 3, 4 and 5). However even with ploughed in stubble some very fertile fine textured soils of the central and eastern wheatbelt are unlikely

Fig. 2.—WONGAN HILLS RESEARCH STATION
Second successive crop on "new" light land. Considering the three central plots:—That on the left received sulphate of ammonia at 224 lb./ac. at seeding. The centre plot received sulphate of ammonia at 56 lb./ac. at seeding, while the plot on the right received no nitrogenous fertilizer. Note the marked increase in early growth of the crop. The wheat grain yields from the three plots were (from left to right) 24, 15, and 8 bushels/ac.

to give an economical response to nitrogenous fertiliser.

Weather Conditions.

If all essential nutrients are available to a growing crop in adequate amounts weather conditions will determine the grain yield. If the weather lengthens the period suitable for growth, yields will be higher, as also will be the increase in yield from the use of a fertiliser that corrects a deficiency of some nutrient. In W.A. cereal districts, suitable temperatures and available moisture for growth usually continue longer in the southern districts than in districts north of Perth. The longer growing season of the southern districts gives greater opportunity for nitrogenous fertilisers to increase grain yields.

If heavy rain falls shortly after nitrogenous fertiliser is applied, much of the fertiliser may be washed out of reach of the plants' roots especially when the crop is very young. On "light" soils in districts of high winter rainfall this sometimes occurs and the crop is poor even when nitrogenous fertiliser has been used. Where these conditions occur early planting with suitable varieties is desirable.

Conditions Giving Widely Different Results.

From the discussion of soil nitrogen and weather it follows that newly cleared gravelly or sandy surfaced soils in districts with a long growing season are most likely to give profitable increases in cereal grain yields from the use of nitrogenous fertilisers. These conditions are common for example, in the country eastward from Mt. Barker to Hopetoun and Esperance. By contrast, on the fertile heavy soils of the eastern wheatbelt, where the growing season is comparatively short, increases in yield will not be obtained with nitrogenous fertiliser. Indeed grain yields have often been reduced in trials, probably because the increased leaf growth with added nitrogen exhausted the moisture more rapidly than did the leaves of the untreated crop. This produced shrivelled grain.

WHAT RESULTS MAY BE EXPECTED FROM USING NITROGENOUS FERTILISERS ON MY FARM?

The map (Fig. 6) shows the results which may be expected in various parts of the main areas for cereal grain production.

The average increases in yield obtained from experiments, using a dressing of sulphate of ammonia at 56 lb./ac. are listed below for each of the zones on the map.

Zone A.

Three trials with oats on heavy and light land gave an average increase of 0.2 bush./ac.

For wheat, 14 trials on heavy land showed no increase and 9 trials on light land gave an average increase of one bush./ac.

Zone B.

In 7 trials, oats (grown mainly on new light land), have shown an average increase of 4.7 bush./ac. The highest increase was 8.5 bush./ac.

For wheat, 21 trials on light land showed an increase of 2.5 bush./ac. Some of these trials were on old clover land. The best increase was 6 bush./ac. On heavy land 6 trials gave one bush./ac. increase. Only two of these latter trials were on intensively cropped land and they both gave profitable increases.

Zone C.

In 14 trials, oats have shown an average increase of 5 bush./ac. on new light land. The best increase was 15 bush./ac.

For wheat, 11 trials on new light land gave an increase of 2.8 bush./ac. with a maximum increase of 6 bush./ac. On fine textured soils (medium-heavy land) some of which had grown subclover, 7 trials gave an increase of one bush./ac.

With barley 4 trials on new light land, showed an average increase of 6 bush./ac. The greatest increase was 12 bush./ac.

Some of these trials in Zones B and C were on land that had grown subclover prior to cropping. On selected areas of new light land low in nitrogen available to the crop it is likely that the increase in yield would be much greater than the *average* increases quoted above. In areas with a long growing season these responses would be substantially increased by using the equivalent of 112 lb. of sulphate of ammonia/ac.

WHAT ARE THE COMMON NITROGENOUS FERTILISERS?

In Western Australia the following nitrogenous fertilisers are most readily available:—

Sulphate of ammonia.
Urea.
Calcium ammonium nitrate.
Nitrate of soda.

HOW SHOULD NITROGENOUS FERTILISERS BE APPLIED?

There are three possible methods of application:—

(a) Mixed with other fertiliser applied at seeding.
(b) Topdressed separately.
(c) Applied as a spray.

Fig. 3.—CHAPMAN RESEARCH STATION

1960 wheat crop on ploughed in 1959 stubble on medium textured soil previously down to subclover. The plot on the left received sulphate of ammonia at 1600 lb./ac. in 1959. The plot on the right received no nitrogen in 1959, but 200 lb. of sulphate of ammonia per acre in 1960. Plots on the extreme left and right of the plate received no nitrogen in either 1959 or 1960. Note the big increase in growth and darker colour of the crop receiving sulphate of ammonia. This effect can be expected on crops planted on ploughed in stubble.

Mixed with Other Fertiliser.

Although it is usual to mix nitrogenous fertilisers with other fertiliser (generally superphosphate) applied at seeding, there are some disadvantages.

Sulphate of ammonia-superphosphate mixtures tend to cake if kept for long periods, but the lumps are soft and readily break up. If the mixture becomes moist through storage under damp conditions it will set hard on drying.

When urea is mixed with superphosphate the mixture becomes damp and at high rates of urea quite sticky. A mixture of 25 lb. of urea and 150 lb. superphosphate will flow through a drill but can cause trouble in damp weather. It is recommended that urea-superphosphate mixtures should not be used.

Plant numbers and early growth have often been reduced when sulphate of ammonia is mixed with superphosphate and the mixture drilled with the seed. This effect has been shown by rates of sulphate of ammonia as low as 28 lb./ac. The reduction occurs if the soil is moist at seeding and no rain falls for some days after seeding. At the rate of seeding normally used yield is not reduced. However it would be more satisfactory if seed and sulphate of ammonia could be separated at seeding, either by using a second fertiliser box, or a twin boot which places seed and fertiliser in separate furrows. The latter might give better results than the other methods: no experiments to verify this have been possible.

Overseas reports show that urea also can have an injurious effect if placed close to the seed.

Topdressed.

If the nitrogenous fertiliser is topdressed either just before or just after seeding, no damage will result and yields will be similar to those obtained with fertiliser drilled with the seed. The weeds in a crop are more likely to be stimulated by nitrogenous fertiliser if it is topdressed rather than drilled with the seed.

High rates of sulphate of ammonia or urea can be safely topdressed on to a crop even when the plants are half grown. The leaves of the crop should be dry at the time.

Topdressed nitrogenous fertiliser must be spread evenly for maximum effect. Spinner type machines are unlikely to be satisfactory; dropper types give more even application.

Sprayed.

Because the nitrogenous fertilisers in common use are very soluble in water, their use in sprays can be considered.

With highly concentrated sprays some crop damage may occur. However, if the spray is to be applied from an aircraft, only small volumes per acre can be used, and this necessitates the use of concentrated solutions. Urea is better than the other nitrogenous fertilisers for this purpose. Experience has shown that large amounts of urea per acre can be applied to wheat by spraying, without damage. For example, an application of 176 lb. of urea dissolved in 100 gal. of water, per acre, left white deposits of urea on the leaves but no important damage occurred. It is believed that 25 lb. of urea in 5 gal. of water, per acre, could be safely applied. Such a solution could be readily made at normal winter temperatures. It should be noted that 25 lb. of urea in 5 gal. of water will give about six and three-quarter gal. of solution.

Spray application by aircraft may be useful when paddocks are too wet for land machines, but otherwise spraying has no advantage over the other methods of application.

AT WHAT TIME ARE NITROGENOUS FERTILISERS BEST APPLIED?

Likely times of application are:—

(a) At seeding.
(b) During the growing period.
(c) Part at seeding, and part during the growing period.

At Seeding.

If the nitrogen is applied at seeding on sandy soils in wetter areas there is a possibility that heavy rains will wash some of it away from the roots of the young plants. This risk is reduced if the crop is planted early to allow more growth of roots and more absorption of nitrogen before heavy winter rains fall.

Sodium nitrate is more likely to be leached than urea, which in turn, is more readily leached than sulphate of ammonia. Calcium ammonium nitrate would be more likely to have leaching losses than would sulphate of ammonia.

Fig. 4.—ARRINO

Second crop of oats, on burnt stubble, on medium textured soil. Note the large increase in early growth on the centre plot which has received sulphate of ammonia at 112 lb./ac. This site had not grown subclover previously. This demonstrates the response that can be obtained on intensively cropped soils of moderate fertility in the better rainfall areas.

The early application of nitrogenous fertiliser stimulates growth before the coldest part of the winter. It has been mentioned already that sulphate of ammonia, *drilled with the seed,* sometimes reduces plant numbers and early growth. If the fertiliser is topdressed this does not occur. At rates less than 112 lb./ac. any early setback is not important.

In general, application at seeding is recommended when nitrogenous fertilisers are used.

During Growth.

If the nitrogen is applied during the growing period, it is less likely to be washed from the soil by rain, and the crop is less likely to run out of nitrogen towards the end of the season, but tillering and early growth will not be as good as when the fertiliser is applied at seeding.

When the application is left until late in the season yields may be little affected, although protein content of the grain will be increased. However, in one experiment a September spray of urea increased oat yields by nine bush./ac.

If nitrogenous fertiliser is broadcast, the crop will not be able to utilise it until rain falls and washes it into the soil. This can cause late applications to become in effect, very late applications, because at this time (late August-early September) there is a good chance of prolonged spells of dry weather.

Split Application.

The advantage of dividing the nitrogenous fertiliser into two parts, one being applied at seeding and the other during the growing period, is that early growth is encouraged and there is also less chance of the crop being acutely nitrogen deficient towards the end of the season. However, an extra application cost is incurred with this method.

Under conditions experienced in Western Australia the use of nitrogenous fertiliser hastens the maturity of the crop in most cases.

WHICH NITROGENOUS FERTILISER SHOULD BE USED?

The prices of the commonly available nitrogenous fertilisers, as judged by their nitrogen content, vary considerably (Table 1). A unit of nitrogen is taken as 1 per cent. of a ton (22.4 lb.). Therefore a ton of urea contains 46 units of nitrogen and a ton of sodium nitrate contains 16 units of nitrogen. Although the price of a ton of urea is double that of a ton of sodium nitrate, it contains almost three times

the amount of nitrogen and is therefore much cheaper per unit of nitrogen.

TABLE 1

Price of Common Nitrogenous Fertilisers (Nov. 1, 1960)*

Fertilizer	Nitrogen	Price/ton Perth	Price/unit of Nitrogen (22·4 lb. Nitrogen)
	%	£ s. d.	£ s. d.
Urea	46·0	66 0 0	1 8 8
Suphate of ammonia	20·5	29 15 0	1 9 0
Calcium ammonium nitrate	20·5	36 0 0	1 15 1
Sodium nitrate	16·0	32 0 0	2 0 0

*N.B. –Prices of nitrogenous fertilisers were greatly reduced in the six months to October, 1960. The prices are as quoted for November 1, 1960

Besides the fertilisers listed in Table 1, others are available that release their nitrogen slowly in the soil. These fertilisers, such as dried blood, crayfish meal and ureaform, are too highly priced to be used in the cereal growing areas. Experiments with ureaform over a two year period have shown that it is not as effective as sulphate of ammonia.

Perth price is not the only consideration in buying nitrogenous fertiliser.

Urea available at present has the lowest unit price. It has other advantages also:—

(1) It is a very concentrated source of nitrogen; it is cheaper to transport and cheaper to apply by aircraft than the other common nitrogenous fertilisers.

(2) Used as a spray it is less damaging than the other common fertilisers.

Disadvantages are:—

(1) When mixed with superphosphate the product becomes sticky.

(2) Urea as such is readily leached, and is not taken up rapidly by plants, but fortunately it soon changes in the soil to forms that are not easily washed away. If heavy rains fall on sandy soils just after application of urea, this fertiliser may be washed away more easily than ammonium sulphate.

(3) Gaseous losses of nitrogen from urea broadcast on sandy soils, have been reported from overseas.

Urea always contains in varying amount a compound called biuret. This compound can be toxic to some plants but cereals are practically unaffected. At the rate of application used on cereals all grades of urea fertiliser sold at present are satisfactory.

Sulphate of Ammonia has these advantages:—

(1) It can be mixed with superphosphate.

(2) It is not readily washed out of the soil, and it can be absorbed by cereals without first undergoing changes.

Fig. 5.—MINGENEW

Second crop on ploughed in stubble on fine textured soil. This was the third crop in four years. The centre plot had no nitrogenous fertiliser, those on the left and right had sulphate of ammonia at seeding. This shows how big responses can be obtained on intensively cropped fine textured soils, particularly if stubbles are ploughed in.

Disadvantages are:—

(1) When drilled with the seed, plant numbers may be reduced, but with rates less than 112 lb./ac. the reduction is not important.

(2) If sulphate of ammonia is used frequently, particularly on coarse textured soils, soil acidity may be increased to harmful levels. Urea has a similar but smaller effect.

Fig. 6

MAP OF MAIN CEREAL GROWING AREAS OF W.A.

Showing Probable Responses in Grain Yield to Use of Nitrogenous Fertilisers.

Zone A—Some increase probable on yellow sandy soils and deep sands. May not be payable. No increase likely on heavy land.

Zone B—Payable increase likely on first crops on newly developed light land.
Increases likely on medium and heavy land, if frequently cropped to cereal, and especially if stubbles are ploughed in.
Small chance of payable increase on first crop after clover ley.

Zone C—As for Zone B but greater certainty of payable increases with crops on newly developed sandy and gravelly soils of scrub plains, mallee or timbered areas.

Broken lines mark boundary of the main area for cereal grain production.

This problem is unlikely to occur if sulphate of ammonia is applied at low rates, e.g., 56 lb./ac., at intervals of three or four years.

Commercial Calcium Ammonia Nitrate has an advantage in that it contains calcium and magnesium and therefore does not increase soil acidity. Calcium ammonium nitrate can be mixed with superphosphate but should be used shortly after mixing. Part of its nitrogen is in the nitrate form and this can be readily leached. This fertiliser is an attractive proposition except for its price.

Sodium Nitrate has all its nitrogen in the nitrate form. Nitrate is readily taken up by plant roots but it is easily leached. Because of its price sodium nitrate cannot be recommended.

WHAT RATE OF APPLICATION SHOULD BE USED?

Where the soil is very low in nitrogen and where a reasonable growing period can be expected a rate of fertiliser equivalent to sulphate of ammonia at 112 lb./ac. should be used. This would generally apply in Zone C of the map (Fig. 6). It should be noted that 50 lb. of urea supplies as much nitrogen as 112 lb. of sulphate of ammonia.

In drier districts, e.g., Zone B of the map, or on soils of reasonable fertility in areas of longer growing season, an application equivalent to sulphate of ammonia at 56 lb./ac. should be satisfactory.

It must be stressed again that response to nitrogenous fertiliser will vary with the season. Because good results are obtained with it in one season, farmers should not think that the same results will be obtained every season. Naturally, if poor results are obtained one year the same reasoning holds.

It must be understood that most of the crops grown in the cereal districts would show an increase in growth and deepening of colour if nitrogenous fertiliser were used. In many cases this growth and colour difference does *not* bring about increases in grain yield. (See Fig. 1.)

WILL THE NITROGENOUS FERTILISER HAVE AN EFFECT THE YEAR AFTER APPLICATION?

Under Western Australian conditions it is unlikely that nitrogenous fertilisers used at recommended rates on cereals will have a residual effect the following year. Two experiments on newly cleared sandy soils showed that applications of sulphate of ammonia at 56 or 112 lb./ac. had no residual value the year after application. Residual benefits were recorded in 1960 experiments on plots which had received a very heavy dressing of sulphate of ammonia (1,600 lb./ac.) in 1959. In these trials wheat was planted on ploughed-in wheat stubble. In 1960 the effect of 1,600 lb./ac. applied in 1959 was superior to that of 400 lb./ac. at seeding in 1960. Sulphate of ammonia used at rates lower than 200 lb./ac. in 1959 had no noticeable effect on the 1960 crop.

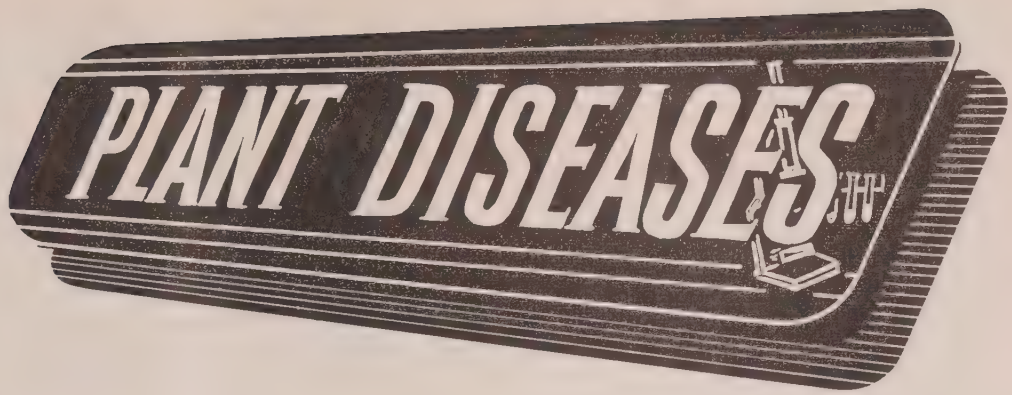
NITROGENOUS FERTILISER DOES NOT REPLACE SUPERPHOSPHATE

Nitrogen is not a substitute for the phosphorus required by crops. No reduction in rate of superphosphate should be made when a nitrogenous fertiliser is used. Also the effects of copper and zinc deficiencies are more apparent when nitrogenous fertiliser is applied, so it would be unwise to apply nitrogen and omit copper and zinc when deficiencies of these two nutrients are known or suspected.

It should be noted that the standard recommendation for super and trace elements for a crop on new light land is one bag (187 lb.) of super copper zinc mixture per acre. The use of sulphate of ammonia at 56 lb./ac. in addition will increase the total fertiliser to 243 lb./ac. If 112 lb./ac. of sulphate of ammonia is to be used the total fertiliser application should be about 300 lb./ac.

DISTRICT AGRICULTURAL ADVISERS MAY BE CONSULTED

Advisers stationed at Geraldton, Moora, Merredin, Northam, Narrogin, Katanning, Bridgetown, Mt. Barker and Esperance may be consulted for advice about the use of nitrogenous fertilisers for cereal crops in their districts.



Bare Patch and Poor Emergence of Cereals

FACTORS UNDER INVESTIGATION

2.*—Depth of Planting

By S. C. CHAMBERS, M.Sc., Plant Pathologist

DEPTH of planting appears to have an important influence upon the emergence of a cereal crop. Increasing the depth by one inch within the range 1-5 inches, not only depressed the emergence counts of wheat seedlings, but also increased the number which emerged abnormally.

During the past three years many reports of poor emergence of cereals have been investigated and it has become apparent the condition is caused by several factors. Many of the early observations pointed to deep sowing as an important cause, because bare patches often occurred where the combine had sunk into soft ground during seeding.

It was these observations which led to the following experimental work being undertaken, to evaluate the effects on emergence of sowing wheat at various depths.

EXPERIMENTAL

Seed of the wheat variety Gabo, was planted by hand at depths of 1, 2, 3, 4 and 5 inches in small plots at South Perth on the 2nd and 3rd August, 1960. The soil in the experimental area was a coarse sand, which is typical of the Swan coastal plain.

The experimental design for the test plots was a simple randomized system, containing 10 replications of the five sowing depths. Each component plot contained 100 seeds, sown in 10 rows of 10, with a space interval of 2 in. between each seed.

Each seedling was examined as it emerged from the soil and rated as normal or abnormal in accordance with the following system:

Normal—coleoptile emerges from the soil before the appearance of the first leaf.

Abnormal—coleoptile fails to appear and the first leaf emerges from the soil.

* The first of the series, entitled "1. Seed Treatment and Moisture Content," was published in the March issue of this Journal.

Emergence counts were taken five weeks after sowing (Table 1) and these were analysed using the transformation arcsin $\sqrt{\%}$ value (table 2).

TABLE 1

Percentage emergence of Gabo wheat seedlings in relation to depth of sowing.

Depth of Sowing (in inches)	Percentage		
	Emergence		Non-Emergence
	Normal	Abnormal	
1	92·7	2·8	4·5
2	76·1	15·3	8·6
3	31·6	52·5	15·9
4	4·9	45·9	49·2
5	0·5	32·5	67·0

TABLE 2

Analysis of emergence counts using the transformation arcsin $\sqrt{\%}$ value.

Depth of Sowing (in inches)	Transformed Values		
	Emergence		Non-Emergence
	Normal	Abnormal	
1	74·1	9·6	12·2
2	60·1	23·0	17·0
3	34·1	46·1	23·5
4	12·8	42·3	44·2
5	4·0	34·7	54·7
Diff. for Sig. P = 0·05	5·2	5·1	3·7
0·01	7·0	6·8	5·0

DISCUSSION

During recent years, there has been an ever increasing tendency to sow very large acreages of cereals in the minimum of time by working shifts for 24 hours a day. This "mass production" attitude has resulted in less care being taken during the actual seeding operation. In some instances, the sowing depth is set on the combine at the commencement of seeding and remains unchanged for the whole of the operation. Consequently, the depth of sowing varies as the seeder goes over various types of ground, sinking in some places and riding high in others.

In normal emergence, the coleoptile functions chiefly as a protective tube for the young foliage, which grows up through it to the surface.

In abnormal emergence, the coleoptile fails to reach the surface and emergence is made difficult for the first leaves which grow by elongation of the basal portions. The subsequent growth of such seedlings is influenced markedly by the soil barrier, through which the leaves must grow to reach the surface.

When the seedling is close to the surface, the basal growth of the leaf will push its tip through, often at an angle. At greater depths, the basal growth will cause the leaf to arch upwards, and these leaves often emerge in a bow-like manner with their tips still buried beneath the surface.

However, when a seedling cannot overcome the soil barrier and fails to emerge, it becomes grossly elongated and distorted before exhausting the food reserves of the seed.

The importance of the planting depth on emergence is clearly emphasised by the results contained in tables 1 and 2. For example, with a planting depth of 4 inches, 49% of seedlings failed to emerge compared with 16% at 3 inches. However, 3 inches also was too deep for sowing, because, although 84% of the seedlings emerged, only 32% were normal.

These results suggest the best depth to sow wheat is less than two inches and possibly within the range of 1 to 1½ inches. However, it is stressed that the experiment has been carried out in a coarse sandy soil and so the results will not necessarily be applicable to all soil types.

ACKNOWLEDGMENTS

The author is indebted to Mr. L. Price for assistance with the field work and to Mr. M. Thornett for statistical analyses of results.

POWDERY MILDEWS OF ORNAMENTALS

By the PLANT PATHOLOGY BRANCH

POWDERY mildews occur on a variety of ornamental plants. As the name suggests, these diseases always appear as a greyish white powdery coating on the leaves. This is easily removed by rubbing or weathering, but beneath it a dark web-like discoloration of the leaf surface often develops. Under some conditions these diseases can be very serious and cause considerable defoliation, stunting and malformation in such plants as Roses, Lagerstroemia (Crepe Myrtle), Hydrangea, Michaelmas Daisy, etc. (see figures 1-5 for symptoms on various ornamentals).

CAUSE

Powdery mildews are caused by fungi belonging to the family *Erysiphaceae*. Usually one particular species of fungus only attacks closely related plants, so that the organism causing powdery mildew in roses is different from that causing the disease in Crepe Myrtle or Hydrangea. However, all the powdery mildews are encouraged by overcast humid weather.

Fig. 1.—**Powdery Mildew on Rose Leaf.**—Note the dusty coating on the leaf. The obvious mildew is easily removed from the leaf by rubbing or weathering, but a dark web-like discoloration is present. The leaves become malformed and eventually fall.

The disease is most prevalent in spring and autumn but may continue right through the summer, particularly in shel-

Fig. 2.—**Powdery Mildew** on Rose Stem and Bud.

tered, shady garden situations, or where humid conditions are brought about by frequent overhead watering.

CONTROL

1.—Spraying.

Powdery mildews are very difficult to control once they have become well established. For this reason, prevention should be aimed at rather than cure, and suitable

Fig. 3.—Severe **Powdery Mildew of Lagerstroemia.**—Note the young shoots are completely covered with a white mildew, looking almost as if they have been dipped in flour. Comparatively healthy leaves are shown on the left

sprays or dusts should be applied when symptoms of the disease first develop. Applications at intervals of 7-14 days may be required during susceptible periods to check disease development. The sulphur containing fungicides have proved most satisfactory over the years for controlling this type of disease. Water dispersable powders of colloidal or wettable sulphur, or liquid sulphur are suitable spraying materials and these should be applied at the concentration recommended by the maker. On the other hand, if dusting is desired "flowers of sulphur" may be used. None of the available organic fungicides has proved satisfactory with the exception of Karathane which is about equal to the sulphur compounds for control purposes. Irrespective of whether sprays or dusts are used, it is essential to apply a light uniform coating to the leaf and stem surfaces if good control is to be achieved.

When pruning mildew affected roses, it is advisable to remove any diseased wood and the application of a dormant spray of lime sulphur at the rate of one part in twenty parts of water is also beneficial. This material is a useful insecticide as well as a fungicide.

In the case of *Lagerstroemia* (Crepe Myrtle), the mildew persists from season to season in infected dormant buds. For this reason, control by fungicides is relatively ineffective, unless heavy winter pruning is also practised.

2.—Situation.

Wherever possible, select an open sunny situation for growing plants known to be susceptible to powdery mildew.

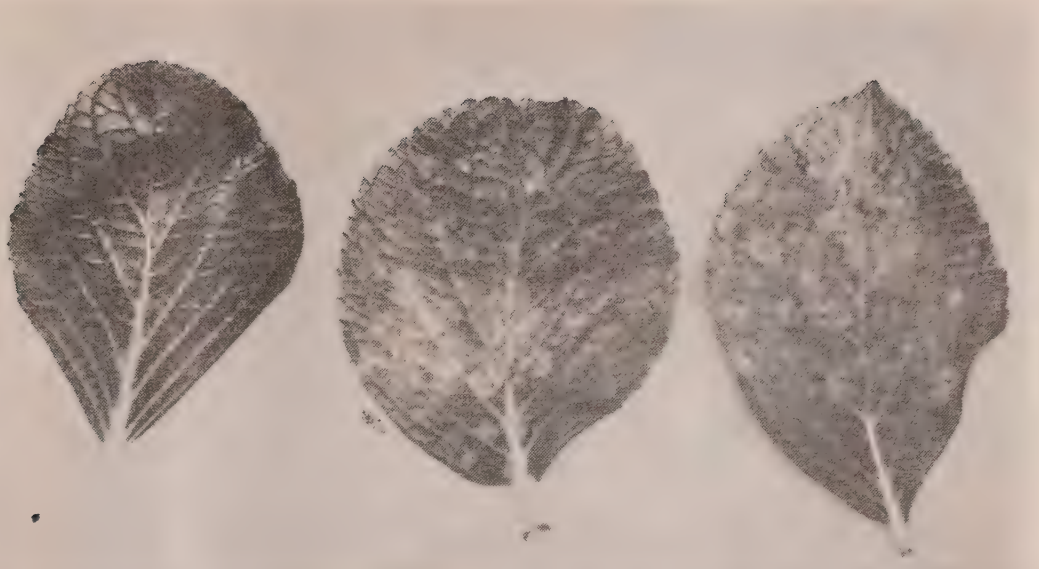


Fig. 4.—**Powdery Mildew of Hydrangea.**—Note the patches of greyish mildew on the leaves. A healthy leaf is pictured on the left for comparison

3.—Resistant Varieties.

When available, choose varieties which are known to have some resistance, for the more sheltered areas of the garden. Resistant rose varieties include the Hybrid Tea Roses—Karl Herbst (red), Montezuma (salmon red), Anne Letts (pink), Sutter's Gold (apricot yellow), Peace (yellow with pink flush), Grandmère Jennie (similar to Peace) and Spek's Yellow (butter yellow); the Floribundas—Spartan (coral orange) and Queen Elizabeth (pink); and the Grandiflora—Roundelay (dark red).

The mauve Crepe Myrtle is more resistant than either the pink or red varieties.

4.—Garden Hygiene.

Always rake up and burn fallen diseased leaves, prunings, etc., to reduce the sources of infection round the plants.

5.—Watering.

Water in the morning rather than the evening so that the foliage dries off quickly.

PRECAUTIONS

Do not spray with sulphur or Karathane during the heat of the day or under heat wave conditions as burning of the foliage will result. Temperatures above 80° F. can cause burning.

Fig. 5.—**Severe Powdery Mildew of Michaelmas Daisy.**—Note the white powdery coating on the leaves and stem

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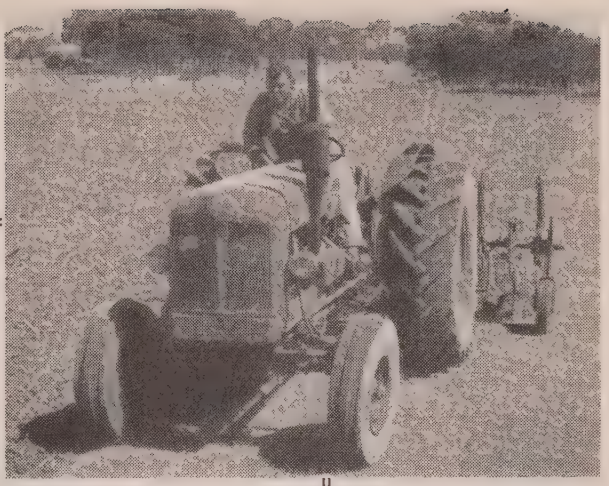


AUSTRALIAN TRACTOR TESTS

★

REPORT ON TEST No. 34
(Farmers' Edition)

FORDSON POWER MAJOR

(Tested for Ford Motor Co. of Australia Pty. Ltd., Geelong, Victoria)

THIS Report is taken from the full Technical Report No. 34 of this test; test results are shown here in briefer form: fuller explanations are added. Values quoted may be rounded out to two instead of three significant figures; to this extent the values may differ slightly but not significantly from those shown in the Technical Report. Some values are taken from graphs shown in the Technical Report, which are not shown here. The Technical Report is not available in large numbers, but it may be seen at, and copies of this farmers' report may be had from, the offices of the State Departments of Agriculture, the Bureau of Sugar Experiment Stations (Queensland), and the Commonwealth Department of Primary Industry.

1. THE TESTS

Special Note:—This is the first test carried out under a new procedure, in which the main tests of engine performance are done directly on the engine itself (removed from the tractor for the purpose), and not through the belt pulley as formerly.

The belt outlet has been abandoned as the main test at several overseas testing stations in favour of tests on the engine itself (Germany) or on the p.t.o. (Nebraska and British Standard tests).

After running-in, three types of tests were carried out, in order to measure *the performance of the engine,* as directly measured by the power in the engine crankshaft (shaft horse-power, s.h.p.), *the performance of the power outlets,* measured on the p.t.o. and belt pulley at their proper speeds, and *the performance of the tractor as a whole,* as measured by drawbar pull, tractor speed, wheel slip, and drawbar horse-power (d.b.h.p.), with the tractor running on a bitumen test track.

The main results of these tests are given in Sections 2 and 3. Other measurements and observations were made of various features of the tractor; these are given in Section 5.

The Australian Tractor Testing Committee is a joint body established between the Commonwealth, the States, and the University of Melbourne; under this agreement, the tests are carried out by the University of Melbourne. The address of the Tractor Testing Committee is: c/o Department of Primary Industry, 301 Flinders Lane, Melbourne.

2. SUMMARY OF POWER OUTPUT

Table A. (See note (a) below)

	Engine C'Shaft	P.T.O.	Belt Pulley	Draw Bar
Full power—h.p.	50·4	34·7	40·5	42·1
At engine speed—r.p.m.	1,700	(*b*)1,200	(*c*) 1,400	1,700
Fuel economy—lb./h.p.-hr.	0·39	0·43	0·42	0·45
Fuel consumption—lb./hr....	19·6	14·8	16·9	20·0
Fuel consumption—gal./hr.	2·4	1·8	2·1	2·4

Rated Speed—1,700 r.p.m.

Fast Idling Speed required to give full power at rated engine speed—1,950 r.p.m.

Crankshaft Torque—at rated speed, 155½ lb. ft.; maximum 165 lb. ft. at 1,200 r.p.m.

Best Economy—0.37 lb./s.h.p.—hr. at ¾ load at about 1,400 r.p.m.

(*a*) Observed values, no atmospheric corrections applied to diesel engines.

(*b*) Engine speed required to give British Standard p.t.o. speed of 540 r.p.m.

(*c*) Engine speed required to give British Standard belt linear speed of 3,100 f.p.m.

3. DRAWBAR TESTS

(1) The following Tables B, C, and D, show the drawbar performance of the tractor, on the bitumen test track, on rear tyres 14 x 30, carrying maximum weight (1,980 lb. front, 6,220 lb. rear; total 8,200 lb.), working in the gears named in the tables. Height of drawbar 18 inches.

Drawbar tests, using standard weight of tractor (7,060 lb.), were carried out, but are not reported here.

Table B.—Maximum Power, Rated 3rd Gear.

Rated engine speed, 1,700 r.p.m.	DBHP (*d*)	Pull lb.	Speed m.p.h.	Wheel Slip % (*e*)
Observed maximum d.b.h.p. at rated engine speed	42·1	4,300	3·67	8

Table C.—Pull at Maximum d.b.h.p.

All gears, rated engine speed. See note (*f*).

Gear	D.B.H.P.	Pull lb.	Speed m.p.h.	Wheel Slip %
1	32 (*g*)	6,000	2·0	16
2	41	5,550	2·8	12
3	42	4,300	3·7	8
4	43	3,025	5·3	6
5	44	2,150	7·6	4
6	Road gear not tested			

Table D.—Fuel Consumption, Various Loads, Rated (3rd) Gear.

Pull lb.	Percentage of full load	Speed m.p.h.	DBHP	Slip %	Fuel	
					Gall./ hr.	lb./ d.b.h.p. hr.
1,900	44	4·46	22	3	1·5	0·53
2,500	58	4·30	29	5	1·7	0·49
3,100	72	4·19	35	6	2·0	0·46
3,750	87	4·02	40	7	2·2	0·45

(*d*) D.B.H.P. is the product of pull (*lb.*) and speed (*m.p.h.*) divided by 375.

(*e*) Wheel slip can be measured by noting that, in travelling a given distance, the back wheels make more turns when working under load than when running with no load on the drawbar. The differences in these revolution counts divided by the former count gives the slip as a ratio, which can be written as a percentage (quoted in these tables to the nearest whole number.)

(*f*) There are not the maximum pulls available in the gears i.e., not the maximum sustained pulls), but the pulls at maximum d.b. power, i.e., at full-throttle at engine speed.

(*g*) Part throttle, maximum d.b.h.p. in first gear limited by wheel slip.

(2) *Tractor Weights (lb.).*

Weight Condition	Front	Rear	Total
Standard, unballasted (*h*)	1,980	5,080	7,060
Full weight, heaviest recommended (*i*)	1,980	6,220	8,200
Includes—			
Water ballast (lb./wheel)	....	540	540
Solid ballast (lb./wheel)	....	30	30

(*h*) This weight, including driver and fuel, was used in finding centre of gravity.

(*i*) Weight of tractor in drawbar tests quoted in this report.

(3) *Wheels and Tyres.*

Tyres	Front	Rear
Type	Rib	Open centre bar tread
Size	7·50 x 16, 6-ply	14 x 30, 6-ply
Pressure	28 p.s.i.	14 p.s.i.

4. THE TEST TRACTOR

(1) The test tractor was declared to have been chosen at random from the current run of production. It received no special attention during assembly; the standard pre-delivery checks usually carried out by the dealer were in this instance done by the Company's representatives at the Testing Station.

(2) *Fuel Settings.*—The engine of this tractor has only one fuel setting, at which all the tests were carried out.

(3) *Governor Control.*—The engine was under the control of the governor set to give full throttle, and so maximum power at rated engine speed. See section 2 above, fast idling speed.)

(4) *Fuel.*—Distillate, Diesel Index 66, Specific Gravity 0.82; weight per Imperial gallon 8.15 lb.

(5) *Specification.*—Engine No. 1524131. See also Section 7.

5. OTHER OBSERVATIONS

(1) *Duration of Test.—Eighty hours,* including running-in.

(2) *Repairs and Adjustments.*—The fuel pump and several injectors were serviced or replaced during preliminary running.

(3) *Engine.—Fuel pump setting checked* —within specified limits.

Radiator water used—none.

Lubricating oil—S.A.E., 20.

Weight to engine, 14.6 lb.;

Weight from engine after tests, 12.0 lb.

(4) *Steering.*—With track widths, front 54½″, rear 59″, wheel base 80″:—

Turning circles: Without brakes 29′ L.H., 27′ 8″ R.H.; with brakes, 20′ 9″ L.H., 20′ R.H.

Comment: Easy to steer under load, sensitive to steering wheel; no power assistance.

(5) *Centre of Gravity,* with tractor in standard weight—level with and 22½″ forward of rear axle.

(6) *Driver's Accommodation.—Access to seat,* from either side forward of rear wheels. *Foot-room and support,* flat foot plates adequate.

Comfort: deep plough-type seat with rubber cushion and back rest. Seat folds up for weather protection, and has quick release adjustment for pushing back for stand-up working. *Accessibility to controls,* satisfactory.

Noise: sound pressure level measured 3 ft. above loaded seat, in open field—

at full power, rated speed—103 units;

at fast idling speed—94 units.

The special unit is the decibel (db) of pressure compared with a base level of virtual silence. The levels quoted above are typical of tractors, which generally are noisy by accepted industrial standards.

(7) *Instruments.*—All clearly visable, markings adequate. Indications were consistent throughout tests. Engine tachometer is marked for standard p.t.o. and belt speeds and road speeds in the gears.

(8) *Inspection of Engine and Transmission after Test.*—After testing, the tractor was partly dismantled and inspected and found to be in a satisfactory condition.

(9) *Instruction Books.*—Instructions for starting, running, and maintenance were satisfactory, and well illustrated.

6. INTERPRETATION OF TESTS

(1) *Power at Outlets (p.t.o. and Belt).*

P.t.o. and belt outlets should run at their recommended speeds, which in this instance conform to international standards. The figures shown in Table A represent the powers available at those speeds.

More power is available at higher engine speeds; for example, at greater engine speed (1,700 r.p.m.) belt power is 46 h.p., but belt linear speed would then be much above that recommended.

(2) *Fuel Consumption—*

Fuel consumption in galls./hour, though a simple unit often quoted, has little meaning unless the corresponding power output is also quoted. *Specific fuel consumption* (lb./ h.p.-hr.), the weight of fuel consumed per unit of energy developed, is a better guide. The unit of energy here is the h.p.-hr. (similar to the electrical unit, the kilowatt-hr.). When specific fuel consumption is least, the engine is giving its best economy or efficiency.

Gallons per/hr. may be changed to lb./h.p./hr. as follows (referring to Table A above):—

2.4 galls./hr. while developing 50.4 h.p. means 2.4 ÷ 50.4 galls./s.h.p./hr. = 0.048 gal./s.h.p./hr.

0.048 gall./s.h.p./hr. x 8.15 lb./gallon for this fuel = 0.39 lb./s.h.p./hr., as shown.

(3) *Drawbar Tests—*

(i) Drawbar tests are carried out on a hard prepared surface. Most field conditions present higher resistance to the tractor's motion, so that, in the field, the maximum drawbar pulls available in any gear will usually be less than those shown in the tables.

(ii) Wheel slip may also be greater in the field; to that extent tractor speeds in miles per hour in the field will be less than those shown in the tables.

(iii) Because of (i) and (ii) above, the drawbar horsepowers available in any gear in the field will usually be less than those shown in the tables.

7. BRIEF SPECIFICATIONS

Fordson Power Major

Based on Information Supplied by Manufacturers for standard drive model)

(1) *Engine*—No. 1524131,

4-stroke; 4 cylinders, vertical; crankshaft along tractor; direct injection diesel.

Bore, 3.937″; stroke 4.524″; compression ratio, 16 : 1.

Rated speed: 1,700 r.p.m. (for drawbar work).

Other recommended speeds: for p.t.o. work, 1,200; for belt work, 1,400 r.p.m.

Fuel type: Distillate.

Fuel system: Simms 4-cyl. in-line pump, 4-hole spray type injectors. Two replaceable-element filters in series. Tank capacity, 15 gallons.

Air Cleaner: Oil bath, perforated metal and fibre pre-cleaner.

Governor: Pneumatic, incorporated in fuel pump.

Electrical system: 12-volt battery and generator.

Starting: Electric, cold start.

Cooling: Water (pressure system), 2-blade fan, pump, and thermostat.

Exhaust: Vertical ahead of operator. Fordson spark arrester.

Lubrication: Oil pump, sump gauze filter, external replaceable-element filter.

(2) *Chassis*—

4-wheel; pneumatic tyres

Wheel base 80″.

Track widths: Front 50½″ x 4″ steps to 74″; rear 59″ not adjustable.

Tyre sizes: Front 7.50 x 16; rear 14 x 30.

Steering: Recirculatory ball drive.

Weight: Maximum, 8,200 lb.

(See Section 3 (2) above).

(3) *Belt Pulley*—

Right hand side, forward working, clockwise rotation.

Diameter 8½″; face width 6¼″.

2 speeds (at 1,400 r.p.m. engine speed), high, 1,400 r.p.m.; low 1,779 r.p.m.

Belt speed (at 1,400 r.p.m. engine speed), high 3,115 ft./min. in accordance with overseas standards (namely, 3,100 ± 100 f.p.m.).

(4) *Power Take-Off*—

Centre rear; anti-clockwise; guarded.

Speeds: at 1,200 r.p.m. engine speed, 540 r.p.m., in accordance with overseas standards (namely, 536± 10 r.p.m.).

Dimensions: 6 spline, 1⅜″ diameter.

(5) *Drawbar*—Swinging—9 positions across.

Height, as tested, 18″ (adjustable 18″, 20″, 22″).

Linkage mounted drawbar also available.

(6) *Tranmission*—Conventional gears.

Clutch: Single dry plate; 11″ diameter.

Gear ratios and road speeds (assuming no wheel slip) on 14 x 30 tyres, at rated engine speed, as advertised.

—	Forward						Reverse	
Gear	1	2	3	4	5	6	H	L
Ratio	123·0	87·3	68·4	48·6	34·8	19·3	50·7	91·1
Speed m.p.h.	2·2	3·1	4·0	5·6	7·8	14·0	3·0	5·4

(7) *Hydraulics*—Built in, gear pump in rear-axle housing.

(8) *Three-point Linkage*—Generally conforms to BS1841-1951, Category 2.

G. H. VASEY, Officer in Charge Tractor Testing.
W. F. BAILLIE, Tractor Testing Officer.
15th May, 1960. University of Melbourne.

Portion of the variety trial area on Mr. C. Horne's property, Manjimup

POTATO VARIETY TRIAL

By J. P. FALLON, B.Sc. (Agric.), Vegetable Adviser, and G. C. de HAAN, Vegetable Instructor, Manjimup

DELAWARE has been the only variety of Potato grown commercially in Western Australia. This is due to the fact that in the past an early maturing variety with a short dormancy period has been required to suit both hill plantings and swamp crops. However, with the advent of sprinkler irrigation and hence better control of moisture and growing conditions, the need for early maturing varieties has ceased to exist in some districts. There has been consequently an increasing interest in testing varieties which have proved high yielding and of good quality in other parts of the world.

Over the years a large number of varieties have been tested by the Department of Agriculture in the potato growing areas throughout our South-West. As a result of some of the more recent trials, two varieties namely Sebago and Kennebec have been selected as showing promise for commercial use, particularly for the karri slopes in the Manjimup and Pemberton districts where sprinkler irrigation is used. These varieties are widely grown in the Eastern States and the United States of America, where they are regarded as high yielding, good quality varieties.

Some growers may ask why should we look for a variety other than Delaware for Manjimup and Pemberton. Each year, growers in these areas produce high yielding crops of Delaware potatoes. However, due to the tendency for the Delaware variety to form knobby and misshapen tubers the yield of saleable potatoes is not always as high as desired. Losses of up to 30% due solely to second growth are not uncommon. This, and the fact that Delaware is more susceptible to Early Blight than some other varieties has prompted the testing of other varieties for their suitabil-

ity for these districts. Two trials carried out in the Manjimup area in the last year are reported in this article, together with comments on the characteristics of the varieties.

Both trials were carried out on the property of Mr. C. V. Horne of Middlesex, Manjimup. The first was planted in October, 1959. Approximately $\frac{1}{3}$ acre of each of the varieties Delaware, Sebago and Kennebec was planted. Six rows 15 chains long of each variety were planted as a block, fertiliser used was 25 cwt./acre potato manure. Width between plants was 10 in. and rows were 34 in. apart. The reason for planting in $\frac{1}{3}$ acre blocks of each variety rather than in smaller randomised plots was due to the fact that in previous trials where plots had been randomised, varying susceptibility to Early Blight and different lengths of growing season caused some varieties to go down prematurely. However, in order that the trial could still be analysed statistically, each row was harvested independently and weights before and after grading recorded.

During growth the crop was irrigated and received a watering approximately once a week when rainfall was inadequate. Each irrigation was equivalent to 1-1$\frac{1}{4}$ in. of water. The crop was sprayed against potato moth and Early Blight after each irrigation. Average yields per acre for each variety are shown in the attached tabulation. Statistical analysis of the results indicated that Kennebec and Sebago gave significantly greater first grade yields than Delaware. There was no significant difference in first grade yields of Sebago and Kennebec.

Trial 1—August Planting.

Variety	Yield/acre Grade I		Yield/acre Total		% Grade I
	tons	cwts.	tons	cwts.	
Sebago	14	6	17	5	83.8
Kennebec	14	14	16	4	90.4
Delaware	11	19	15	7	77.7

On grading the potatoes the following observations were made. Delaware gave a good sample without much second growth. However, it is considered that a better sample would have been obtained had the planting been at 12 in. instead of 10 in.

Kennebec produced a coarse sample, and it was obvious that the planting distance with this variety would need to be much reduced. Many tubers which made up the Grade I sample in this variety were so big as to be unsightly and unfit for general use.

The trial area receiving its weekly irrigation.

In some rows 50% of the tubers were grossly oversize. However, as there is no limit to size in present grading regulations, these tubers were classified as Grade I. A considerable amount of greening in the variety was also noted.

Sebago gave the most satisfactory sample throughout. As could be seen from the figures, a high percentage of uniformly well shaped and good sized Grade I tubers was obtained.

In a subsequent trial carried out in the summer planting, the same three varieties were compared. In this case, 8 rows of each of the varieties were planted in a ½ acre block, each row again being approximately 15 chains long. The same planting distances were used as previously. Potato manure was applied at the rate of 25 cwt./acre and cultural practices were carried out as in commercial production. During the growing period, it was noticed that germination in the Sebago crop was not as good as in other varieties. Rhizoctonia was also severe and seriously affected the trial. Results in average yields per acre and percentage of Grade I tubers are shown tabulated hereunder. Analysis of the results indicate that while Kennebec out yielded both the Delaware and Sebago variety in this particular trial, there was no significant difference between Sebago and Delaware.

Trial 2—December Planting.

Variety	Yield/acre Grade I		Yield/acre Total		% Grade I
	tons	cwts.	tons	cwts.	
Sebago	10	3	14	16	70.2
Kennebec	15	19	17	12	90.7
Delaware	10	17	16	5	66.8

Although it is not unusual in the Manjimup and Pemberton districts to find Delaware crops with a high percentage of second grade tubers, it is most unusual to find a high percentage of second grade Sebago. Although no second growth was noticed in Sebago, a considerable amount of cracking and stem end rot was evident, and this greatly reduced the yield of Grade I tubers of this variety in the trial. The following comments are made as a result of experience to date with each of these varieties:—

Kennebec.

This variety matured approximately one week earlier than Delaware. The tubers are characterised by being large, elliptical to oblong, medium thickness with shallow eyes. They have a smooth skin which is creamy to buff, and are white fleshed.

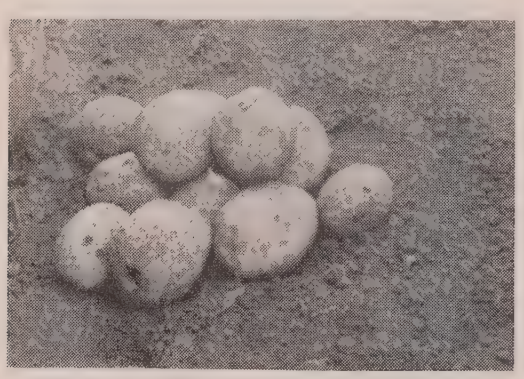
Kennebec.

This variety has shown itself to be fast growing and high yielding. The tubers however were found to be often rough and oversize and subject to cracking. As they are inclined to set close to the surface they are subject to greening. It is considered that this variety is a difficult one to grow under irrigation and would require considerable care with regard to determining the correct spacing for fertility and moisture conditions to produce a uniform line of tubers. It is likely that Kennebec would perform well in the hill crop in the South-West districts, particularly if planted with round seed, and provided that steps were taken to overcome its tendency towards greening.

Sebago.

Maturity of this variety was 2 to 3 weeks later than Delaware. Tubers were inclined to be large, elliptical to round elliptical, medium in thickness with smooth skin, shallow eyes and white flesh. This variety has good resistance to Early Blight and drought, is not subject to second growth and is high yielding. It has been

demonstrated that Sebago is no more susceptible to hollow heart than Delaware when grown under the recommended spacing conditions. The variety is inclined to set only a few tubers per plant particularly when cut seed is used and hence spacing of the variety should be close in the row to prevent oversize tubers being



Sebago

formed. It is advisable to plant where possible, large size cut setts or round seed. Where cut seed is used for planting Sebago summer crops, care must be taken to ensure that the setts are either planted immediately into cool ground or are very carefully callused if a satisfactory germination is to be obtained. The tubers are most attractive in appearance and have an extremely short dormancy period. Where this variety must be stored for long periods for ware purposes during warm conditions, the use of a sprout inhibitor would be advantageous.

Delaware

Delaware has been the only commercial variety grown in the State for approximately 50 years despite the testing of other varieties. It is a medium late variety with elliptical to oblong tubers of medium thickness. The skin is smooth and of creamy buff colour. Eyes are medium to deep pitted, and the same colour as the skin. Tuber flesh is white. This variety is susceptible to Early Blight and second growth. Although generally a high yielding variety, percentage of first grade tubers is at times disappointing. Nevertheless, this variety has proved adaptable to a wide range of growing conditions in the State.

Delaware

Summary and Recommendations.

The trials indicate that under the conditions at Manjimup, the varieties Sebago and Kennebec are likely to yield as well as or to out yield the Delaware variety normally grown. This and the fact that each possesses other desirable characteristics should ensure that they will find a place in W.A. potato growing.

Growers are urged however, to be extremely careful when growing for the first time a variety with which they are unfamiliar. Every effort should be made to become well informed on the characteristics of the variety which it is intended to plant and to adjust growing techniques to suit the peculiarities of that variety. For instance, these trials reported on here have clearly indicated that each of the three varieties tested has specific yet different requirements for spacing within the row if an even line of tubers is to be obtained. Finally, when obtaining seed of a new variety for testing purposes growers should make certain that the variety they get is true to name. Many instances could be cited of growers obtaining unsatisfactory results with a certain variety which subsequent tests have shown to be incorrectly named.

ACKNOWLEDGMENTS

The co-operation of Mr. C. Horne and family in conducting the trial is gratefully acknowledged.

Thanks are due to the Biometrics Section of the Plant Research Division for statistical analysis.

THE GRANNY SMITH

By F. MELVILLE, B.Sc. (Agric.), Adviser (Fruit)

MOST of the commercial apples grown throughout the world today have originated as chance seedlings and commercialised by observant nurserymen or fruit growers. Many Tasmanian varieties were established this way—the Sturma, Democrat and Crofton. But the seedling which has had the greatest impact on apple growing in Australia is the Granny Smith and its rise to fame is an interesting story.

It is recorded that way back in 1867 Maria Ann Smith wife of the Mayor of Parramatta in New South Wales bought some empty gin cases at the Sydney Market and in one were some decaying apples. These were tipped out at the foot of the garden at her home in the suburb of Ryde and by chance a seedling developed from one of the fruits. Little did Mrs. Smith realise as she cared for the young tree that this apple was later to become the famous Granny Smith, an apple which has changed the pattern of apple growing in many areas of Australia and particularly Western Australia.

It was not until the end of the last century that the commercial possibilities of the Granny Smith were recognised by nurserymen. It spread to all States of the Commonwealth soon after the turn of the century and the first trees arrived in Western Australia about the beginning of the first world war. At first, they were mistaken for Cleopatras but it was soon realised that here was an apple with much greater potential and from the twenties onwards plantings increased rapidly. A survey in 1946 showed that more than a third of apple plantings in this State were Granny Smiths and since then it has dominated all new plantings. Something approaching 75 per cent. of the apple trees planted during the last 15 years have been Granny Smith. The variety is, of course, prominant in New South Wales and also South Australia. In Victoria it accounts for 25 per cent. of the apple production and in Tasmania for about 10 per cent. In this State production has reached a million bushels in a good year and exports have been as high as 700,000 bushels.

Interest in the Granny Smith has not been confined to Australia alone. It is now being grown commercially in New Zealand, in South Africa and large plantings have also been made in the Argentine. These countries are all competing on the United Kingdom and European markets and Argentine in particular is likely to prove a very strong rival.

The Granny Smith has emerged as a premium variety on the United Kingdom market second only to Cox in market value and is also rapidly gaining acceptance on the Continent. It is also popular in Singapore. It is surprising that a green apple has been able to establish itself in the dessert apple trade and speaks well for its excellent quality.

The secret of success of the Granny Smith lies not in any single attribute but in its versatility. It grows under a wide range of conditions from the Granite belt of Queensland to the cool temperate climate of Tasmania and from the irrigated areas of the Murray Valley to the hot non-irrigated conditions in this State. It grows well, yields well and from the growers point of view is a sound variety. From the shippers angle it has a long season with good continuity of supply. The first Australian shipments reach the United Kingdom in early April and continue until the final shipments in early August. To the importer it provides

limited risk because of its good keeping qualities and although not highly flavoured appeals to the consumer because of its crisp texture and dual purpose nature.

On the debit side there are some disadvantages. There is a distinct tendency to biennial bearing in older trees with the typical on and off years. This can now be corrected by judicious use of chemical thinning and this year has demonstrated what can be achieved with a heavy crop.

A more elusive problem is apple dieback which commences as a stoppage of the leaders and develops as a progressive dieback. Pruning the declining leaders only worsens the position by allowing the entry of wood rotting fungi. Although dieback may be related basically to the climate conditions no doubt anything which devitalises the tree such as root injury by nematodes or curculio or overcropping under adverse conditions will hasten its appearance. Soil fumigation has resulted in improved growth and cropping but it is too early to tell whether there is any direct effect on dieback.

As the Granny Smith apple approaches maturity it increases in size very rapidly. On young and light crop trees the apples can easily become too large for market requirements and there is a tendency to pick immature with the result that Bitter Pit develops if the fruit is stored. This large early fruit is best disposed of as soon as possible after picking and should not be stored.

The Granny Smith matures, quite slowly as compared with varieties such as Jonathans and Cleos which makes it very difficult to tell by appearance when the fruit is suitable for harvesting. There are no satisfactory tests which can be applied to guide the grower so he must rely to a very large extent on experience, taking into account the purpose for which the fruit is required.

Granny Smiths harvested before the end of March are mainly for the early Singapore market. The fruit is usually from light crop trees and is pit liable.

Pickings in the first fortnight of April supply fruit for the early shipments to the United Kingdom. This is better storage fruit and wrapped in oiled paper will carry successfully. However, Granny Smiths picked at this time are very subject to superficial scald if stored after mid August particularly if low temperatures are maintained. If oiled wraps are not used then the scald will develop earlier and be much more severe.

Fruit to be shipped unwrapped should not be picked before the second half of April.

Fruit for long storage must be selected fruit, that is, from well cropped trees, picked at the right stage and properly sorted. There should be a minimum of delay before cool storage and storage temperature must be right. The biggest problem with long storage Granny Smiths is superficial scald which is normally prominent in market fruit by about October. But with proper attention to storage requirements scald can be reduced to minor proportions. These requirements are, pick during the second half of April, remove all sunburnt fruit at this stage and store as soon as possible at 38°-40° F. Keep the fruit at this temperature until the end of May, then drop the temperature to 32° for the remainder of the period. Trials conducted over a number of years have shown that if this procedure is carefully followed scald need not be a serious problem.

Sunburnt apples even where the injury is very slight will almost certainly develop sunburn scald in store hence the need for eliminating all sunburnt fruit from long storage lines.

The good keeping qualities of the Granny Smith are related to the slow rate of ripening and thick wax coating which limits wilting. Unfortunately, the fact that the Granny Smith is easier to handle than other varieties leads to some abuse. A lot of the Granny Smiths held for the late market are lines rejected for export and often quite unsuitable for long storage. If you want a high quality product *out of store* then high quality fruit must go *into store* and be handled in the best possible way. The extra attention given to selection of fruit, handling and storage will be more than repaid by the results obtained.

Bruising is still a major export problem, particularly with larger sizes and late picked fruit. This problem is receiving attention with the introduction of bulk

bins and carton packs. This season will see the first large scale commercial shipments of Granny Smiths in these containers and should bring some interesting results.

Granny Smith production can be expected to increase substantially in the next few years at the expense of other export varieties. The problem of handling the crop in the normal picking season will increase and the tendency will be to extend the season by earlier picking. At the present time pit and scald are major bars to earlier harvesting particularly if unwrapped fruit is to be shipped. However, trials are in progress to work out answers to these problems and if these are successful coupled with an improvement in the bruising position by the use of new packaging methods the Granny Smith should have a bright future.

The growth of the Granny Smith in Australia may be likened to the development of the Delicious in the United States. Found originally as a chance seedling the Delicious variety now produces almost 30 million bushels of apples annually or approximately 25 per cent. of the total American production. By diligent searching, numbers of new sports have been found with more highly coloured fruit and other desirable characteristics. These sports have now largely displaced the original standard Delicious. It is highly probable that amongst the many thousands of Granny Smith trees established in this State there are odd trees or single limbs which are producing more desirable fruit than the average. There is no reason why improved Granny Smith sports with greener colour better shape, ripening at a slightly different time or with some other desirable characteristic are not in existence. I would like to leave this thought with growers. If you know of a possible sport or come across one during harvest let the local Horticultural Officer know. He will be interested to follow it up and perhaps an improved Granny Smith may result.

(Broadcast 7th Feb., 1961, and printed by permission of the A.B.C.)

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HOARY CRESS

(*Cardaria draba* (L.) Desv.)

Hoary cress belongs to the same family as wild turnip and wild radish but, while they are annuals, it is a vigorous perennial. Native to the Mediterranean region and Western Asia, it has become a serious weed in many other countries including Britain, North America, New Zealand and Australia.

WEEDS of Western Australia

By **G.R.W. MEADLY** M. Sc.
Officer in Charge, Weeds and Seeds Branch

HOARY CRESS

(*Cardaria draba* (L.) Desv.)

HOARY CRESS, known also as Hoary Pepperwort or White Weed, is a perennial plant native to the Mediterranean region and Western Asia. It has spread as a weed to northern Europe including Britain, as well as to other temperate countries among which are North America, New Zealand and Australia.

In Australia, apparently the plant first became established in Victoria, although there are few details concerning the history and manner of introduction. A survey carried out in that State in 1940 showed that 94,000 acres were affected, representing one twenty-sixth of the area annually sown to wheat. It is of greatest economic importance in the central Wimmera district and is considered to be Victoria's worst weed.

Hoary Cress occurs to a lesser extent in Queensland, New South Wales, Tasmania and South Australia, and has been recorded from one locality, Merredin, in this State. There is evidence to indicate that it was introduced to Western Australia as an impurity in a line of agricultural seed.

DESCRIPTION

The term "hoary" applies equally well to the masses of white flowers and the whitish leaves. Cress is quite appropriate as the plant belongs to a genus or group closely related to the garden cress, *Lepidium sativum*.

Hoary Cress is a perennial herb with a branched creeping cord-like rooting system which extends horizontally over a large area and gives rise at intervals to leafy stems. The roots store food reserves which provide energy for subsequent growth, and broken fragments soon produce new plants. The leafy stems are 12-18 inches high and bear leaves from ground level to where the flowers commence. The lowest leaves, forming a basal rosette, are oblong or broad lance-shaped, up to four inches long and tapering into a distinct stalk. The upper leaves are smaller without stalks and encircling the stem at the base. The leaves are usually white-hairy, but the shape, size and hairiness are very variable. The flowers are arranged in racemes usually massed into a terminal inflorescence with crowded buds at the apex and more distant flowers and buds at the base. The small white flowers are similar in shape to those of the related cruciferous weeds such as wild turnip and mustard, which, however, are yellow in colour.

The pod is reverse heart-shaped, each of the lobes containing usually a single pendulous compressed-egg-shaped seed about 1-12 inch in diameter and with a dull dark brown surface.

Hoary Cress is a declared primary noxious weed for the entire State.

SIGNIFICANCE

Stock may eat Hoary Cress to a slight extent, but it has no value in this direction and must be regarded as one of Australia's

HOARY CRESS *(Cardaria draba)*

A, plant, showing habit (about one-third natural size). B, upper stem leaf. C, flower (much enlarged). D, fruits. E and E1, ovary and section of same. F, fruit (pod). G, seed. H, embryo. I, seedling.

(F, G, and I from Bulletin 108, Ministry of Agriculture and Fisheries.)

most serious weeds. It spreads rapidly, establishes itself quickly and is extremely difficult to eradicate. Although a free seeder, the problem of eradication is mainly associated with the extensive development and vigour of the underground parts. The main roots extend downwards to a depth of six feet or more and give rise to a labyrinth of lateral branches at various levels. Spasmodic cultivation only serves to break the rooting system and carry it further afield. Hoary Cress is a strong competitor in the plant world and, being more hardy than most cultivated plants, causes appreciable reduction in yield of both pastures and crops.

As already stated, the Victorian survey made in 1940 revealed that 94,000 acres were infested. At the time of the survey Wimmera farmers considered that land valued at £12-£17 per acre for wheat cultivation, had depreciated with Hoary Cress infestation to £5-£7 per acre as grazing land unsuitable for wheat.

CONTROL

Hoary Cress is far more widely established in Victoria than elsewhere in Australia and most of the control investigations have been carried out in that State. As already mentioned, it is of greatest consequence under cultivation associated with wheat farming, especially on areas showing signs of depletion following repeated cropping. Under such conditions, altering the system of farming to include a period under pasture has helped to reduce the intensity of Hoary Cress, but cannot be regarded as a method of eradication.

A wide range of chemicals have been tried but Hoary Cress has a high degree of resistance. When the small area was located at Merredin a number of years ago, drastic attention was called for without consideration of cost. As various treatments, including the repeated application of arsenic pentoxide, did not prove successful, heavy applications of crude salt were tried, ultimately the whole area being covered at a rate of 30 tons per acre. The tenacious nature of Hoary Cress can be gauged by the fact that some shoots emerged following this heavy dressing.

The chemical approach has been simplified by the advent of the growth regulating herbicides but, even with 2,4-D ester, several applications of 1-2 lb. acid equivalent per acre are necessary. The plants are regarded as being most vulnerable at the early flowering stage. Although this treatment is practical and economical for small areas where eradication is the objective, it does not provide the complete answer for thousands of acres, particularly when the effect of the chemical on pastures and crops must be taken into account.

To the best of our knowledge, Hoary Cress is not now established anywhere in Western Australia and it is very important that any occurrences should be detected early in order that measures may be taken before it becomes widespread. The colour plate and drawing will help farmers to recognise this very serious weed.

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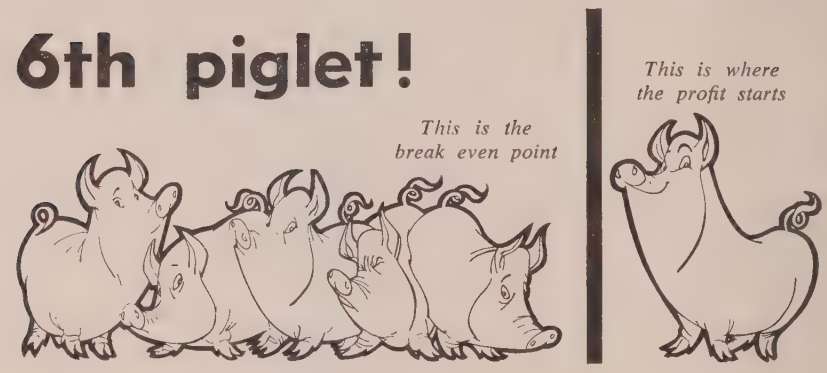

It's common knowledge in farming circles that the profit from a litter of pigs doesn't even *start* until the 6th piglet. This is true of all breeds.

It is obvious, then, that to make a profit the pig breeder must do everything he can to ensure that his sows farrow large litters and rear the maximum number of piglets.

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Honey Flora Calendar for May

COMPILED BY R. S. COLEMAN, APICULTURAL SECTION, WITH ASSISTANCE FROM THE BOTANICAL BRANCH

Common Name	Botanical Name	Where Found	Honey		Quality of Pollen	Remarks
			Quality	Quantity		
Tuart	*Eucalyptus gomphocephala* D.C.	South of Lancelin on the West Coast, to Busselton	Medium	Medium to good	Uncertain	A borer attacks this tree, dropping the buds. Apparently, hot dry weather stops the borers and allows the tree to flower. From the first sign of the bud to flowering is three years. Due to the hot summer this year, the Tuart should flower.
Flat-topped or Swamp Yate	*E. occidentalis* Endl.	Low-lying land in Great Southern	Choice	Uncertain yielder but yields enough to be regarded as a commercial crop	Good	This tree needs strong hives to produce a good crop, borers attack the buds. The Swamp-Yate usually flowers every year.
Wandoo or White-Gum	*E. redunca* Schau. var. *elata* Benth.	Commercial stands occur between Enneabba and Mt. Barker	Choice	Excellent	Poor	The major honey plant amongst the Eucalypts. Flowering on western slopes of the Darling Range, March to May.
Prickly Dryandra	*Dryandra armata* R. Br.	Gravel soil and sheet laterites. Midlands to Great Southern	Medium	Good	Good	Not well known.
Kerosene Bush	*Dryandra Ashbyi* B.L. Burtt	Dongara and northwards. Some may be found south of Dongara in small patches.	Good	Good	Good	A good flow usually follows good opening rains.
Fraser's Dryandra	*Dryandra Fraseri* R. Br.	Gravel soils. Coorow through to Great Southern	Good	Good	Good	This plant is very much like the Kerosene Bush of the north.
White Bell	*Leucopogen conostephioides* D.C.	Widespread	Dark and strong caramel	Good	Good	One of the few plants flowering at this time of the year.
White Heath	*Leucopogon propinquus* R. Br.	Widespread	Poor	Good	Good	Time of flowering is important, to maintain hives in early winter and keep strength up for spring flows.
Mothers Bells	*Leucopogon concinnus* Benth.	Widespread	Poor	Good	Good	Time of flowering is important, to maintain hives in early winter and keep strength up for spring flows.
Menzies Banksia or Red Banksia	*Banksia Menziesii* R. Br.	Coastal Sand Plain	Good	Poor to good	Unknown	Grows in association with other honey-producing plants. Believed to be a source of good first grade honey in some years.

It will be seen from this list that information concerning many nectar-bearing plants is far from adequate. We would appreciate further information from beekeepers.

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Some Notes on

Worms in Sheep in Southern Western Australia

By I. W. PARNELL,* B.A., Ph..D.

DURING the last fifty or more years several surveys have been made of the worm parasites which occur in southern Western Australia. In the 'fifties, thanks to the stimulus of Mr. H. McL. Gordon, supported by Dr. H. W. Bennetts, observations were made on the sequence of the infestations in autumn-born weaners in the country stretching from Moora to Cranbrook and Bridgetown, and later near Geraldton and Esperance.

The surveys have shown that some 22 species have been found in the abomasum and intestines of locally bred sheep, they include most of the parasites which might be expected, with the outstanding exception of the nodular worm—*Oesophagostomum columbianum*, which is a serious cause of loss in northern New South Wales and Queensland. If this species ever becomes established in Western Australia it is most likely to do so in the more fertile districts of the warmer areas of the State. Three species of lung worms have also been found.

The observations made on the sequence of the infestations in autumn-born weaners brought out the most interesting and important fact that there was a marked tendency for the infestations to rise in mid-summer in some areas or somewhat later in other districts, at times when dryness and heat would make it unlikely that many infective larvae were being ingested. The anthelmintic drenching trials, run in connection with these observations, showed the considerable losses in meat and wool production due to parasitism, and that infestations of *Chabertia ovina* alone could cause losses amounting to over a pound of wool per weaner.

In 1959-60 the Wool Research Trust Fund made a grant to the Department of Agriculture, while the Commonwealth Scientific and Industrial Research Organisation, through its field station, Glen Lossie, at Kojonup, provided sheep and other facilities for more detailed observations on the worm burdens of lambs and weaners. In addition, observations were made on some older sheep from Glen Lossie, and on sheep from a few other properties. The laboratory work was carried out at the Animal Health and Nutrition Laboratory, Hollywood.

OBSERVATIONS

The main observations were based on fortnightly worm-egg counts of a group of 72 autumn-born lambs, one of which was slaughtered each week from early June until early May; and on a group of 40 spring-born lambs, from early in November until early in May one of them was slaughtered each week. They were all kept in the same paddock at Glen Lossie.

The contrast in the worm-egg counts and in the worm counts of the two age

* Now at the Hydatid Research Unit, The Medical School, Dunedin, New Zealand.

groups was most marked, and seems to have provided the clue to the reason for the increase in worm-egg counts in summer. This information should provide the basis for planning drenching trials to anticipate the "summer rise."

In the autumn-born lambs and weaners large numbers, many thousands, of immature stages, were found buried in the mucosa and submucosal walls of the abomasa and small intestines, chiefly of the former. These immature stages persisted for several months. On the other hand only a few hundred immature stages were found in the spring-born lambs. It seems, therefore, that the explanation of the "summer-rise" in autumn-born weaners lies in the delayed development of larvae which are picked-up before the spring-born lambs (born in early September) are old enough to ingest many larvae. The Thin-necked Bowel Worms (*Nematodirus* spp.) were exceptions to this picture.

It is, perhaps, of interest that this delayed development of histotropic immature stages probably offers an explanation of the "spring rise" in sheep in the United Kingdom and other countries, and may, perhaps, explain the "parturition," and subsequent "rise" in worm-egg production of breeding ewes.

The "Barber's Pole Worm" *(Haemonchus contortus)* did not occur in these sheep at Glen Lossie. Its absence on this property, and some others, suggests the possibility that a few years of well-timed drenching of all sheep could eliminate it from properties on which the free-living stages can not survive in summer.

In the autumn-born weaners infestations of the "Brown Stomach Worms" (*Ostertagia* spp.) were fairly light, but were most numerous in February and March. The "Small Stomach Worm" (*Trichostrongylus Axei*) increased in numbers a few months earlier. The "Black Scour Worms" (*Trichostrongylus* spp.), of the small intestine, reached a peak in November, but large numbers persisted until well into March. The "Large-Mouthed Bowel Worm" (*Chabertia ovina*) became numerous in mid-December and comparatively large numbers were found until May.

In the spring-born weaners the infestations of adult worms, except of the "Thin-necked Bowel Worms," also were all considerably lighter than in the autumn-born weaners. However, the fall in the levels of the infestations in the spring-born weaners in the autumn was less rapid than in the older weaners.

The life histories of the "Thin-necked Bowel Worms" are basically the same as those of the worms which have been mentioned above; they vary, however, in one important detail, in that the larvae develop to the infective stage in the egg shell and do not break out until some stimulus, probably climatic, enables them to do so. This means that they are much less vulnerable to desiccation. Their development also tends to be slower.

In the United Kingdom serious infestations of the Thin-necked Bowel Worms are nearly always lamb to lamb infestations; that is lambs are infested from eggs laid by the previous year's lambs. At Glen Lossie in 1959-60, the pattern was different. There was an increase in the level of the infestations in the autumn-born weaners in September, followed by another one in midsummer, when the *Nematodirus* egg counts of the spring-born weaners rose to comparable levels. Further observations will be necessary to determine whether this was the normal pattern or whether the rainfall on the last day of December and early in January provided the stimulus which made the *Nematodirus* eggs hatch, and the larvae become available to the grazing weaners.

Another interesting observation was made. Nine wethers nearly 15 months old were taken from Glen Lossie to the Animal Health Laboratory; when they went their worm-egg counts were low, but although they had no further opportunity to pick up infective larvae their worm-egg counts immediately rose rapidly and remained quite high. Over six months later they were drenched with heavy doses of phenothiazine, but within a few weeks their worm-egg counts rose again, although there still was no opportunity for them to be reinfested. This could have been caused by the egg-laying potential of the female worms being temporarily damaged rather than the worms being killed, but it is, perhaps, not very likely, because of the heavy

drenches used. This probably again suggests the significance of "dormant" immature stages in perpetuating parasitism in the sheep of Western Australia when drenchings are not accurately timed.

Another small trial at Glen Lossie illustrated the importance of ewes as the source of infestations of their lambs. Ewes, and their lambs, were being grazed at five, three and one and one-half ewes per acre in a trial run by Mr. H. L. Davies. The worm-egg counts of the ewes at three per acre averaged slightly more than those at five per acre; this apparently resulted in the worm-egg counts of their lambs at first rising even more rapidly than those at five per acre, although the latter overtook them during July. In this trial the worm-egg counts of the lambs with the most lightly infested and lightly stocked ewes were always the lowest; however, in 1960 Dr. M. R. Gardiner found heavy infestations in a paddock stocked at one and one-half ewes per acre.

The observations on other properties all confirmed the importance of worms as a cause of loss of production in Southern Western Australia, not only in the wetter areas, but in districts in which the rainfall is comparatively light.

It is interesting that in April on one pastoral lease in a 10-inch rainfall area, which was carrying an average of one sheep to 25 acres, the worm-egg counts of the autumn-born weaners were high while those of the spring-born weaners were very low, exactly the same pattern as at Glen Lossie; moreover, no Brown Stomach Worms or Large Mouth Bowel Worms had become established in the few spring-born weaners which were sampled.

ESTIMATE OF LOSSES

Until more data are available it is impossible to estimate accurately the loss of production from worms in sheep in Western Australia, even in the southern part. However, if it is assumed that there are some ten million sheep in that area it is possible to make rough guesses at the huge sums worms are costing the State.

Several drenching trials were carried out in the middle 'fifties which pointed to the losses in production of meat and wool which were and still are occurring in sheep in Western Australia. For example near Beverley, the body weights of drenched weaners were 12¼ lb. heavier than those of undrenched weaners and their fleece weights were 2¼ lb. heavier; in another trial the average fleece weight difference was 1 2/5 lb. In trials at Tarwongup and Kojonup drenching increased the body weights of weaners by 2 to 3 lb. and by 4 2/5 lb. respectively; and at Tarwongup copper sulphate-nicotine increased fleece weights by nearly ½ lb., while Diaquone (which would only control *C. ovina*) increased fleece weights by 1⅓ lb. In these trials not only were fleece weights increased by drenching, but the percentages of tender fleeces were decreased.

Probably between a quarter and a fifth of the sheep in the southern part of the State are weaners; it is doubtful whether more than a small proportion of these are being drenched at the right times with the right anthelmintic; if they are, it is more by luck than exact knowledge. In addition there is the loss through decreased growth and deaths. In the United Kingdom it would not be exceptional for the death rate of weaners to be halved by correctly timed strategic drenching.

In other countries well-timed drenching of ewes has led to increased "lamb-marking" percentages and increased fleece weights.

Small scale trials in the United Kingdom have suggested that even light infestations can reduce lamb weights by some 10 lb. by weaning, and by double that weight by when they are a year old; these trials have also shown that infestations in young lambs tend to stunt their bone growth.

As the fat lamb trade increases, the control of worms in lambs, and, therefore, in their dams, will become more and more important. World wide evidence points to the fact than worms delay lambs reaching slaughter weight and all fat lamb producers in Western Australia appreciate the losses involved when lambs have not reached slaughter weights before the feed deteriorates in the summer.

RECOMMENDATIONS

These losses from worms cannot be curtailed efficiently until the exact pattern of the infestations of each of the more common species are known accurately for each age group of sheep or cattle in each typical

district of Western Australia. This necessitates epidemiology trials on all age groups, and, when the patterns are established, then carefully planned drenching trials of each age group in each area. Efficient drenching trials necessitate not only drenching groups of sheep, but also frequent worm-egg counts, obtaining regular body and fleece weights, and, in the case of ewes, lamb-marking percentages of the drenched and the control groups must be noted. This programme would necessitate the employment of several technical assistants, and involve the expenditure of several thousands of pounds for several years, but to incur this expenditure would be good business when it means increasing production by several hundred thousand pounds for an unlimited number of years. Every year that these programmes are postponed, or only half done, delays the time when the benefits will accrue. In the meanwhile the sheep population along the south coast is increasing. This is an area where worms are and will be a serious problem, and where men starting on new holdings need guidance; at present that cannot be given with any certainty that the advice is the best possible.

It is repeated that for the best results the right anthelmintic must be used at the right time and in the right quantities. In the meanwhile individual sheep owners should use the figures quoted above to work out how many hundreds of pounds lack of knowledge of the most efficient anthelmintic drenching programmes may be costing them, and must remember that, because they have been satisfied with certain body and fleece weights for many years, it is not necessarily the target at which they should aim. An adequate helminthological research programme in Western Australia offers exciting and immense scope for research workers and considerable financial gains for sheep and cattle owners, and for the State.

ACKNOWLEDGMENTS

The grant from the Wool Research Trust Fund and the sheep from the Commonwealth Scientific and Industrial Research Organisation are most gratefully acknowledged.

Without the help of Dr. H. W. Bennetts, C.B.E., Dr. M. R. Gardiner, Mr. Malcolm Cobb and others at the Animal Health and Nutrition Laboratory; Mr. E. Watson and Mr. G. Anderson at Glen Lossie; and numerous sheep owners, it would have been impossible to complete even this preliminary research project and to them I offer my sincere thanks.

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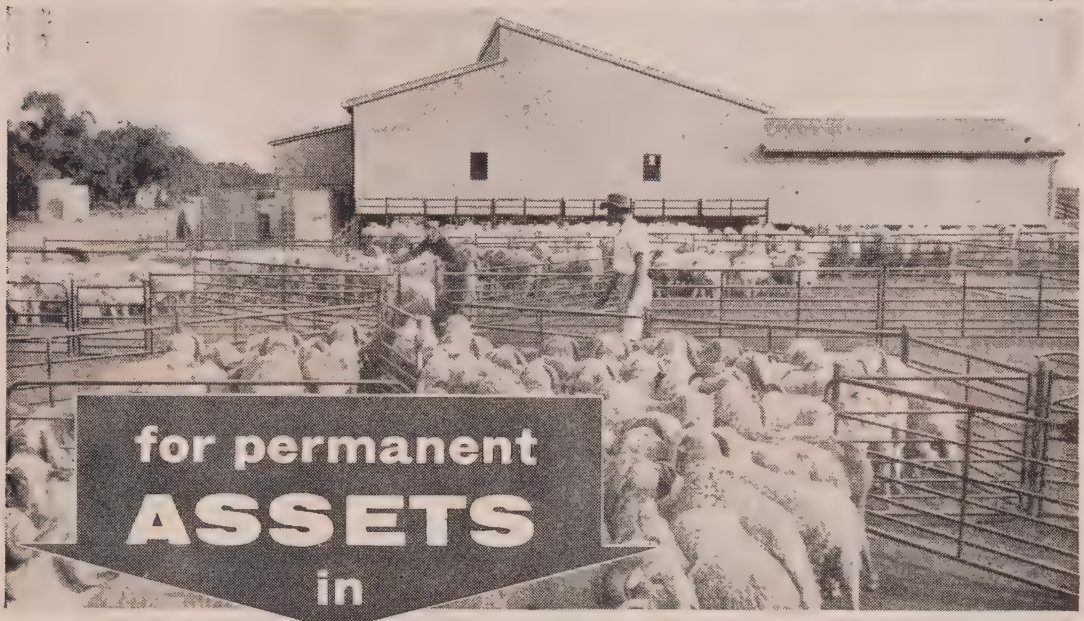

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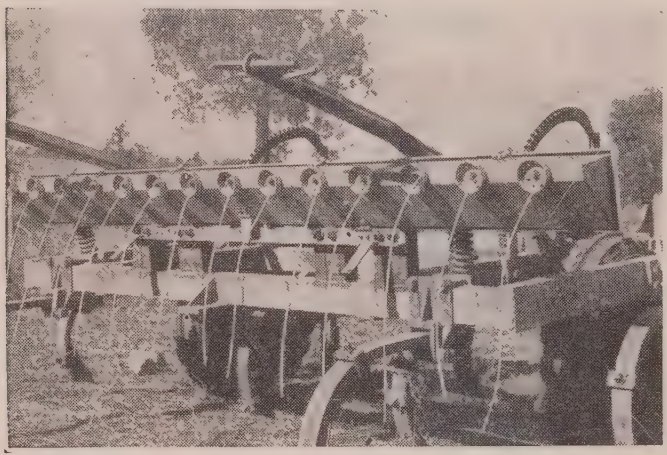

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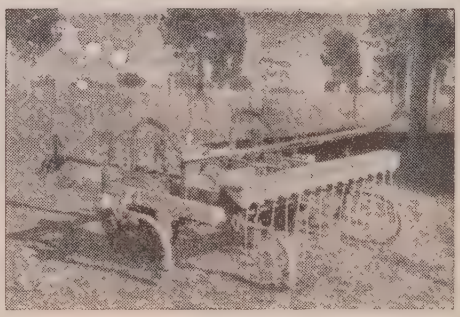

Photo shows "C" Seeder attached to a Yeoman's Graham Chisel Plough (left) in sowing position (far left) in non-sowing position.

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A New Type of SEED BED COVER for the Market Garden

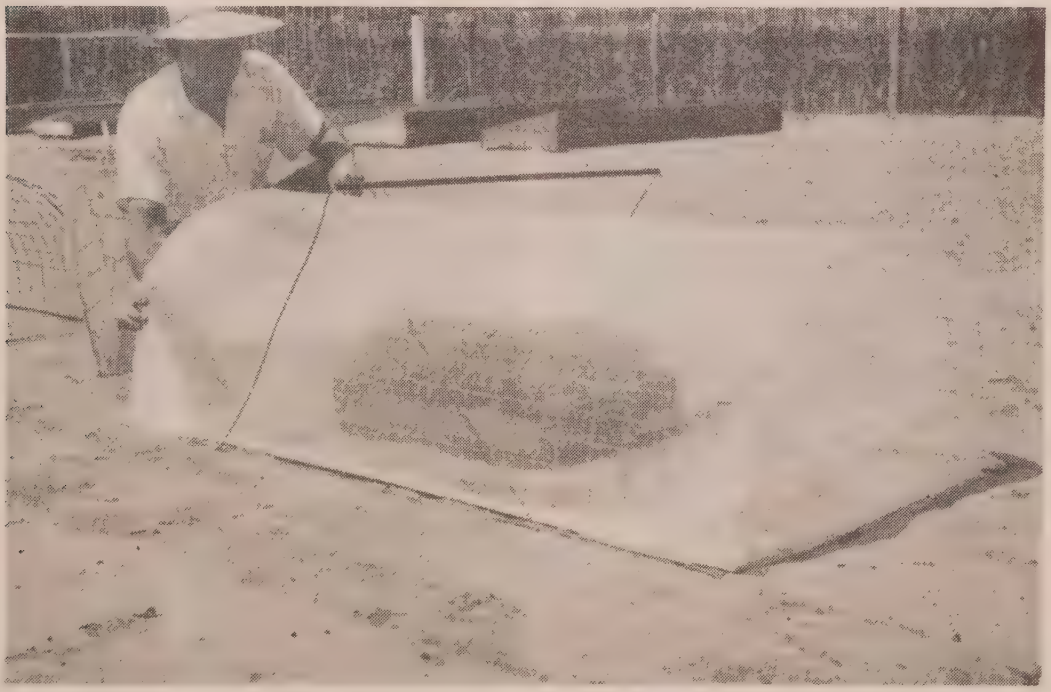
By R. R. BELL, Manager, Vegetable Research Station, Wembley, and M. HARDIE, Vegetable Instructor

ALL market gardeners use seed beds in their gardening programme. However, the basic design of seed beds and covers has not greatly altered over the years. The availability of cheap good quality plastic materials has now shown the way to improvements in the design of this type of gardening equipment.

One of the features of the Field Day held at the Vegetable Research Station last November was a demonstration of a new type of seed-bed cover developed at the station.

The framework for the cover is made from industrial fencing wire and then covered with polythene.

Most people are aware of the construction of the frames that are generally used.



1.—A new type cover with the timber framed ones which were used previously in the background. A box of seedlings can be seen through the polythene

2.—Two seed bed covers with carrying handles. If desired they can be placed end to end

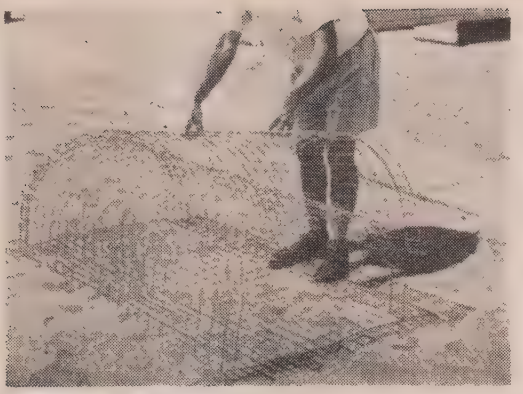
Frequently about eight feet in length they are made from fairly heavy timber. The back is usually higher than the front for weather protection and to catch sunlight. The covering for the top is either glass or windolite in frames or a roll of canvas. They can be adjusted to meet the needs of the weather.

These frames have disadvantages in that being constructed of stout timber they are hard to move and become more or less permanent fixtures—not always in the most convenient site. They are difficult to maintain in the state of hygiene which is necessary for the raising of healthy seedlings.

It had been noticed at the research station too that after a batch of seedlings had been raised to nearly the required size, removal of the wooden frame greatly stimulated growth. It was felt that the freer movement of air was responsible for for this improvement and that a seed bed cover could be constructed which would allow better control of air circulation.

Details of the construction of this new cover are shown clearly in the accompanying photographs. The industrial wire is purchased in sections measuring 6 ft. x 6 ft. and this is curved quite easily to form a semi-circle. A piece of polythene measuring approximately 10 ft. x 6 ft. is used to cover the framework. The thickness of the polythene used at the research station was .004 in. A heavier gauge would have a longer life but would increase the cost. The cost of the wire frame was 22s. whilst the polythene to cover it would be approximately 20s. Two light wooden battens on

3.—The cover tilted when conditions are favourable or for hardening seedlings off



4.—The frameworks stacked one on top of the other for ease of storing

which to roll the polythene at each side and four gutter bolts to hold these in place on the frame would add a few more pence to the total cost.

A carrying handle made from fencing wire and a piece of conduit is clearly shown in the photographs.

The advantages of this new frame over the old type are listed as follows:—

(1) They can be quickly and easily moved to allow fumigation of the soil.

(2) They can be placed in any position as the polythene will allow the entry of light and heat to the seedlings.

(3) The frames can be propped up from either side to allow movement of air through the seedlings and also to act as a windbreak. They can also be easily removed from the seedlings.

(4) When not in use they can be stored one on top of the other, thereby conserving storage space.

(5) They are cheap to construct and should give many years of service.

A further advantage of these covers is that when not being used for raising seedlings they can be used in the curing of vegetable seeds. Most market gardeners grow their own seed for at least one type of vegetable whether it be onion, carrot, parsnip or cauliflower. Containers to hold the flowers when the seed is curing are not always available.

By inverting the seed bed cover and making a shelf from the same industrial wire to fit about the middle of the frame, an excellent container for curing seed is on hand. This shelf also helps to make the frame quite rigid.

5.—The seed bed cover used for curing onion seed

6.—A close up of onion seed curing in the inverted cover

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Explosives arriving at the Kalgoorlie reserve. Transport is by rail from Victoria to Kalgoorlie

BLASTING . . . EXPLOSIVES AND THE FARMER

By G. A. GREAVES, B.Sc., A.R.A.C.I.,
Explosives Branch, Mines Dept.

PART I

ABOUT 3,000 tons of commercial blasting explosives of various types are used every year in Western Australia of which approximately two thirds is utilised by mining industries and the remainder goes mainly to quarrying and public works. The farmer and orchardist actually use only very small amounts but nevertheless explosives are a very useful working tool for the primary producer.

This article will give some general information on the sale of explosives, licensing requirements, types of explosives as well as on deterioration and how to avoid it. In a further article the use of explosives on the farm and orchard will be discussed.

The Explosives Act is administered through the Mines Department and provides a system of licensing, regulation and inspection which applies to the importation, packing, storage and transport of all explosives. It also provides for testing and inspection of all explosives before they are released for distribution and sale. Regulations for the use of explosives are provided under the Mines Regulation Act (1946) and apply mainly to mines and quarries which are supervised by Inspectors of Mines. The man on the land may have had mining experience but otherwise he will not always know the rules for safe-keeping and use of the explosives which can help to develop his property.

DEVELOPMENT OF MODERN EXPLOSIVES

Until about 100 years ago gunpowder was the only explosive available for mining and engineering work and blasting was a very hazardous business until the safety fuse was first invented by Bickford in 1831. Nitroglycerine was introduced for blasting by Nobel about 1860. In the pure liquid form, it caused a number of serious accidents owing to its dangerous sensitivity. Nobel persevered in his efforts to make it safe and in 1866 he produced the first dynamite by aborbing the liquid nitroglycerine on Kieselguhr. At the same time Nobel also invented detonators or blasting caps which could be fired by safety fuse and provide the means of detonation for the less sensitive dynamite. It was in 1875 that Nobel made his greatest discovery by dissolving nitrocotton in nitroglycerine. This resulted in a gelatinous mass much more powerful and more water resistant than dynamite. The mixture was called Blasting Gelatine and it is still the most powerful commercial explosive available.

At the present time blasting explosives are made in a number of grades for different purposes, but all consist of varying proportions of sodium and ammonium nitrates incorporated with nitroglycerine, nitrocotton and some organic matter such as starch or wood-flour. Ammonium nitrate not only provides oxygen but does itself decompose with explosive violence and over the last 30 years it has become

Unloading explosives from the ship's hold at Woodman's Point

widely used in all blasting explosives. It has one disadvantage since it readily absorbs moisture from the air causing the explosive to become soft and wet. For this reason all explosives of this type are packed with waterproof liners inside the case and the plugs themselves are wrapped in waxed paper. Adequate precautions can be taken to prevent deterioration and the use of ammonium nitrate is justified by the added power it gives to the explosive, its safety in handling and transport and greater economy in manufacture.

DISTRIBUTION IN AUSTRALIA

Australia has only one factory producing commercial blasting explosives and all our supplies come from Deer Park near Melbourne. This factory is associated with the original factory established by Alfred Nobel at Ardeer, Scotland about 1880 and its products are distributed through Imperial Chemical Industries of Australia and New Zealand Ltd. who act as agents in all States. The Deer Park factory produces fuse, detonators and a wide variety of blasting explosives as well as other accessories for mining, oil prospecting and special purposes. Supplies come to Western Australia either by rail to Kalgoorlie or by small motor vessels to the Explosives Reserve at Woodman's Point near Fremantle. On arrival, all explosives are inspected and sampled by the Explosives Branch before being released for distribution. Any variation from the agreed requirements for wrapping, packing or general condition of the explosives is noted and reported to the factory for correction. Any explosive or fuse damaged in transit is thoroughly inspected and if necessary destroyed. It is then the further responsibility of the Branch to see that explosives reach the consumer in sound condition and to ensure that they are stored and kept in a safe and secure manner.

EXPLOSIVE TYPES

Many different grades are used for quarrying, gold-mining coal-mining and oil prospecting but the farmer is concerned only with blasting powder, gelignite, safety fuse and detonators. Indeed the country store, where small amounts are purchased, will probably not stock any other explosive since there is no local demand for it.

Blasting Powder is the modern form of gunpowder. It is not a powder but consists of hard pellets about the size of bean seeds. The pellets are polished with graphite on the surface and sold in plastic bags each holding 1 lb. or in bulk bags of 50 lb. Blasting powder is a low or heaving explosive; it reacts by very rapid burning rather than by sudden detonation and is now used mainly for splitting timber since there is less tendency to shatter and splinter. It is also used for splitting monumental stone. It is easily ignited by spark or flame and

Landing explosives at Woodman's Point jetty. Vans are hauled by a tractor to magazines

does not require a detonator; when ignited in the open it produces a sudden flash and a cloud of smoke but no loud report. (This sometimes leads to complaints that the powder is ineffective since no useful work is done unless blasting powder is well tamped into a confined space). Firing is done by the safety fuse with no detonator and because of the sensitivity to flame or spark great care must be taken in its handling and storage. Any spillage onto a hard floor should be thoroughly cleared up and smoking or the use of matches with blasting powder creates a dangerous hazard. It is readily desensitised by water which provides a simple and effective means of decontamination or destruction.

Gelignite is the commonest grade used for all general purposes. It has all the power required for most work without the intense shattering detonation of higher grades such as Gelatine Dynamite or Blasting Gelatine; it is the grade stocked by all licensed stores and purchased by the farmer. Gelignite plugs bear the printed marking "AN Gelignite 60" which may or may not be prefixed by the word "Polar." "AN" refers to the mixture being based on ammonium nitrate and "60" means that it has 60 per cent. of the power of blasting gelatine. The word "Polar" refers to a special grade of nitroglycerine which has a lower freezing point and is suited to cold climates. In Western Australia this is not necessary but for convenience in making up consignments the factory may despatch both types to this State. The plugs are generally 1 in. in diameter but $\frac{7}{8}$ in., $1\frac{1}{8}$ in., and 2 in. are supplied to mines and quarries when required. One inch gelignite is available in both bulk and carton packs. The former is suitable for mines and quarries or for any job where a case is used up in short time while the 5 lb. cartons are recommended for stocking by stores and for the small user. Carton packs are enclosed in waxed paper and each plug is fully coated with wax to protect it from moisture.

To prevent deterioration of gelignite it is most important that it be kept in a cool dry place and protected from moist air. We have already learned that ammonium nitrate is hygroscopic which means it has an affinity for moisture; this is why such explosives become wet and soggy when exposed to the air. Generally the effect is first seen at the ends of the plugs which become soft and wet, finally the the whole plug will deteriorate and free moisture will drip from the explosive. The red colour which exudes is derived from the dyestuff in the mixture. Explosive which has deteriorated in this way is quite unfit for use; even when affected only at the ends there is a marked loss in sensitivity which may prevent communication from one plug to another. It should also be remembered that the exuding moisture carries ammonium nitrate in solution; it is highly corrosive to most metals and can create a potential fire hazard by impregnation of wood, bagging or other organic matter. Such a mess should be thoroughly cleaned up and washed out with water. Of course if the explosive is properly kept and used in reasonable time this will not occur. The farmer keeping a few cartons of gelignite must provide a secure receptacle with a well fitted lid. There are some army disposal stocks which are very suitable for this purpose. Cartons should not be damaged or broken until required for use. Loose plugs keep very well in an air tight tin or a plastic bag. The receptacle should be painted conspicuously with the word "EXPLOSIVES" and kept in a dry, secure lock-up shed.

Safety Fuse consists of a core of fine gunpowder enclosed with alternate layers of textile yarn and bitumen and coloured with a yellow paint pigment for identification purposes. The manufacture of fuse is supervised by artisans with a lifetime of experience at the job and the

Approved type of wooden receptacle for keeping and carrying explosives

Carrying box sold by disposal stores for 7s. 6d.

chemist defers to their expert knowledge. The result is a very reliable product which burns evenly at 90 seconds per yard with very little variation. It is durable and water-proof and will keep for years. There are however two sources of damage which the farmer should bear in mind. Sharp kinks may damage the powder core and cause it to cease burning at that point so that fuse should always be kept in the coil and protected from mechanical damage. Bitumen is easily penetrated by certain solvents including kerosine, diesel and fuel oils and fuse which has been in contact with any oil may fail to burn and should not be used. It should be destroyed by burning on an open fire.

Detonators are small tubes of aluminium charged with very sensitive explosive compositions which are fired by the "spit" of a fuse to give a powerful explosion. The composition is compacted into the tube under high pressure and the modern detonator is reasonably safe. They are, however, spark or flame sensitive and a speck of hot tobacco ash falling into a detonator can cause ignition. The composition is also sensitive to friction and can be exploded by inserting sticks or any hard object into the open end. Although detonators have been dropped without explosion, there is no guarantee that they will not explode and dropping is definitely an unsafe act which should be avoided. They keep well and even after several years, or after wetting by water, they must still be treated with all due respect.

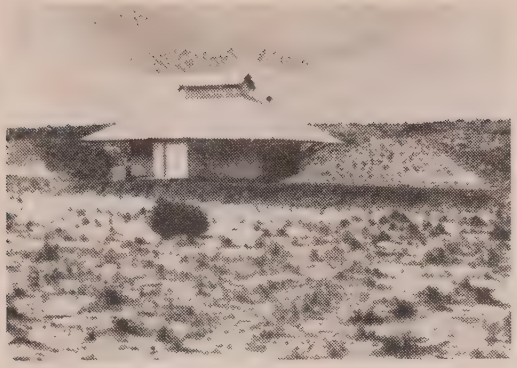
Explosives at a country store: 5 lb. cartons gelignite, 1 lb. bags of blasting powder and 24 ft. coils of safety fuse

It is a general rule that detonators should not be stored close to other explosives; a separate box should be provided, marked clearly and kept in a locked cupboard or drawer. Detonators are always a danger to children who instinctively insert sticks or nails into the open end. The result is severe injury to the hands and possibly the loss of an eye. It is the responsibility of all to keep detonators in a locked place and never to leave them about.

PURCHASING EXPLOSIVES

The farmer should not purchase more than is required for the work in hand so as to avoid storage and possible deterioration. It is best to obtain small quantities as required from a licensed store and if your nearest store is not licensed then application for such license can be made to the Explosives Branch Mines Department.

If larger quantities are required for a particular job the licensed store will order them from Perth or supplies may be obtained direct from Woodmans Point Explosives Reserve between 11 a.m. and 12 noon every Wednesday. No special permit is required but the officer in charge will limit purchase to two cases when carried in a small vehicle; he will also require that no flammable goods are carried at the same time and may refuse delivery if the vehicle or load is obviously unsafe for carrying explosives. Since a farmer generally has no magazine license, his storage should be limited to one case or one day's supply and deliveries at the Reserve will be limited accordingly. There is, of course, nothing to prevent the farmer ordering direct from the Perth agents for delivery by rail to his nearest



A 30-ton magazine at Woodman's Point reserve

siding or station. Generally it is preferred that he purchase in small amounts as required from the licensed store.

LICENSING

Licenses under the Explosives Act are required for importation of explosives, for selling explosives and for storing a quantity of more than one case. The farmer is concerned only with storage and can usually work with quantities which are exempt from licensing. He is however, still required under the Act to provide a secure receptacle and to protect the explosives against theft or fire hazard. Two cases may be stored under license in an approved receptacle but for more than two cases a detached and approved magazine is required. Under common law a person may be held responsible for negligence in respect of any dangerous material which causes injury to another party. Explosives should therefore be kept securely and never left on the job or in places where they might be the cause of an accident. This applies

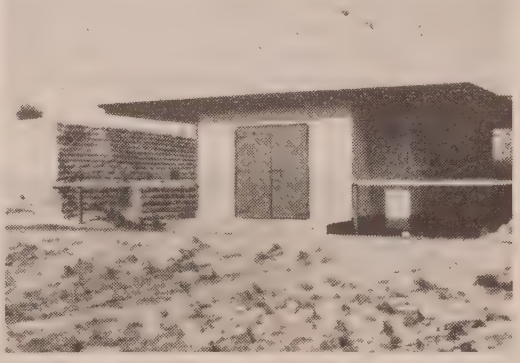
A licensed magazine in the metropolitan area for storage of 50 cases of explosives

especially to detonators which are small enough to be overlooked but can cause severe injury to children who may find them.

The Explosives Branch is always willing to answer any enquiries with regard to licensing, storage or disposal of explosives. Any mishap or accident with explosives should be reported and also any instance in which explosives are received in doubtful condition. Such enquiries or reports should be addressed to The Chief Inspector of Explosives, Mines Department, Perth.

In the next article it is intended to discuss the safe keeping of small amounts of explosive on the farm, the correct manner of preparing charges and some useful applications of explosives in the field of agriculture.

Magazine at Woodman's Point reserve. Capacity, 30 tons



Magazine on Government explosives reserve

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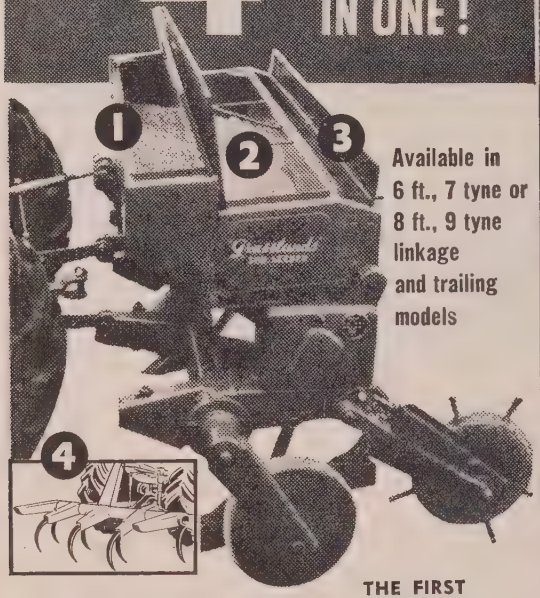

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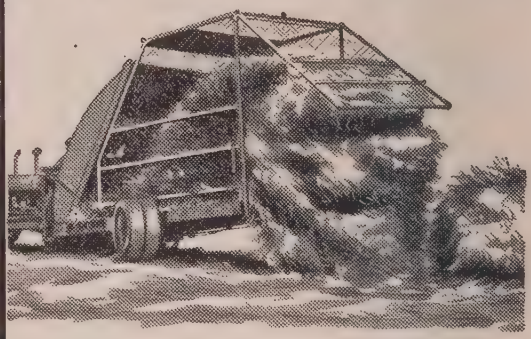

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WINTER PESTS IN THE PASTURE

By P. N. FORTE, Senior Entomologist

ALTHOUGH the pests concerned in attacking winter pastures are known to most farmers a discussion of their control and relative importance will not be out of place. The principal pests concerned fall into two groups. Firstly the red-legged earth mite and lucerne flea whose attacks are most noticeable soon after germination and secondly a group of caterpillars which appear about the same time and whose attack is not noticed until a large amount of damage has been done.

The main caterpillars concerned are those of the webworm, brown looper, day flying moth and tiger moth.

While the flea and mite seem to prefer the subterranean clover these other pests prefer the other plants that go to make up the pasture, for example capeweed, wild geranium and numerous grasses.

The attack of the red-legged earth mite and lucerne flea can be so severe that when a new pasture is being established the plants can be killed out.

In the case of caterpillars in plague numbers we find that the paddocks appear bare. Usually the plants they like are killed out and it is not uncommon to find later in the season an almost pure subterranean clover stand.

This was not an uncommon sight in some areas of the Great Southern and wheatbelt last winter.

We are now in a position to advise that when it is required these pests can be quickly and effectively controlled, with DDT or DDT-malathion mixtures.

This, to my mind, is a tremendous step forward. However, whether the cost of the insecticide and its application is economical for the farmers is one for individual decision.

It seems to me that where one is establishing a pasture, treatment to control pests should be treated as a type of insurance, as considerable money has already been spent in preparing and seeding the ground and no one wants this to be wasted because pests have destroyed all the germinating plants.

In the case of established pastures the circumstances are a little different.

If the conditions after germination are dry then so much damage can be done to the plants even with a small population of pests that large numbers of plants will die. Futher, when conditions are good for growing but the plants are carrying a heavy infestation of pests the pasture can be so retarded that the desired early growth before the winter does not amount

to anything worthwhile and eventually the paddock becomes bare.

I mention these points not as an advocate for overall spraying of the farm with insecticide as this is undesirable, but to assist farmers to make a decision in this important problem. This should be done soon after germination and when the insects start to appear.

Farmers should therefore watch all their paddocks afer the opening rains and by getting first hand information on their pasture conditions and pest numbers thereon should be able to decide whether it is necessary to treat paddocks or not.

Further details of these pests and their control can be obtained from the Department of Agriculture.

IMPROVING POTATO SEED

By J. P. FALLON, Senior Adviser (Vegetables).

SOME of the oldest records of potato cultivation show that throughout the ages it has been generally accepted that periodically, a change of seed is essential, and the only means of maintaining satisfactory yields in crops. Even today most potato growers are familiar with the term "run out" as applied to any particular line of potatoes which tends to progressively decrease in vigour and productivity when planted from year to year.

In the past, this belief was based, no doubt, on the experience of generations of growers who noted improvements in their crops with the introduction of new stocks from areas of certain kinds of soils or climates. Although the benefits resulting from the change of seed to some extent led to the recognition of certain localities as being more suitable for seed production, for many years there was no satisfactory explanation of the causes under-lying the degeneration of potato stocks.

It was not until early this century that it was discovered that the potato plant is susceptible to certain virus diseases and it is now known that these diseases are the main cause of deterioration in seed potatoes, with consequent reduction in crop yields.

Virus diseases are not apparent on the tubers, although carried over from season to season by them. However, they may be detected by the observant grower in the growing crop. As they do not cause spectacular wilting of the plants, rotting or marking of the tubers, as is often the case in fungous or bacterial diseases they may escape the notice of even experienced growers until the yields are seriously affected.

The main virus troubles which affect potato crop yields in this State are leaf roll and a group of diseases known by the term mosaic. Leaf roll, which is by far the most important is spread from plant to plant by certain species of aphides. If infection occurs late in the growing season, plants may not show symptoms, but the disease may have been transmitted to the tubers which if used for seed would produce plants showing the disease.

It will be seen then that the maintenance or improvement of potato seed of any particular variety depends largely on the elimination of virus disorders. It was for this reason that the Department of Agriculture introduced the Certified and Approved Seed Schemes. However, it is not sufficient to leave the business of improving seed solely to the Certified and Approved potato growers. Every grower could and should play a part in seed improvement by preventing the spread of virus disorders. This can be done by carrying out a few simple precautions such as by planting the best seed available and

removing diseased plants from the crop during the growing period.

Many growers when buying seed tend to favour a well-graded line of clean evenly-shaped tubers, but unfortunately, it is not always realised that the appearance of the seed gives little indication of its productive capacity.

Where possible, approved or certified seed, which is the best available should be purchased. In the event of this type of seed being in short supply, the advice of the district officer of the Vegetable Section should be sought as to the best alternative seed.

During the growing period the detection of diseased plants in the crop should be followed by their instant removal. The plants and tubers should be placed in a bag and carried right away from the crop and destroyed. The potato plant is most susceptible to virus infection in the early stages of growth and up to the time of flowering. It is therefore important to reduce the time for which plants are exposed to infection to an absolute minimum by early and persistent roguing.

First symptoms of the leaf roll disease, become noticeable three to six weeks after plants appear above the ground. The lowest leaves of the plant roll up at the margins and become thickened, hard and brittle. The plants affected with the disease are usually stunted and pale with an erect stiff habit due to the rigidity and rolling of the leaflets. An experiment conducted by the Department has shown that leaf roll can reduce the total yield of a crop by as much as 55 per cent.

The importance of the disease cannot be over-emphasised and all growers are urged to take an active part in improving potato seed by eliminating virus disease from their crops.

ESTABLISHING SALTLAND PASTURES

By C. V. MALCOLM, Adviser, Soils Division.

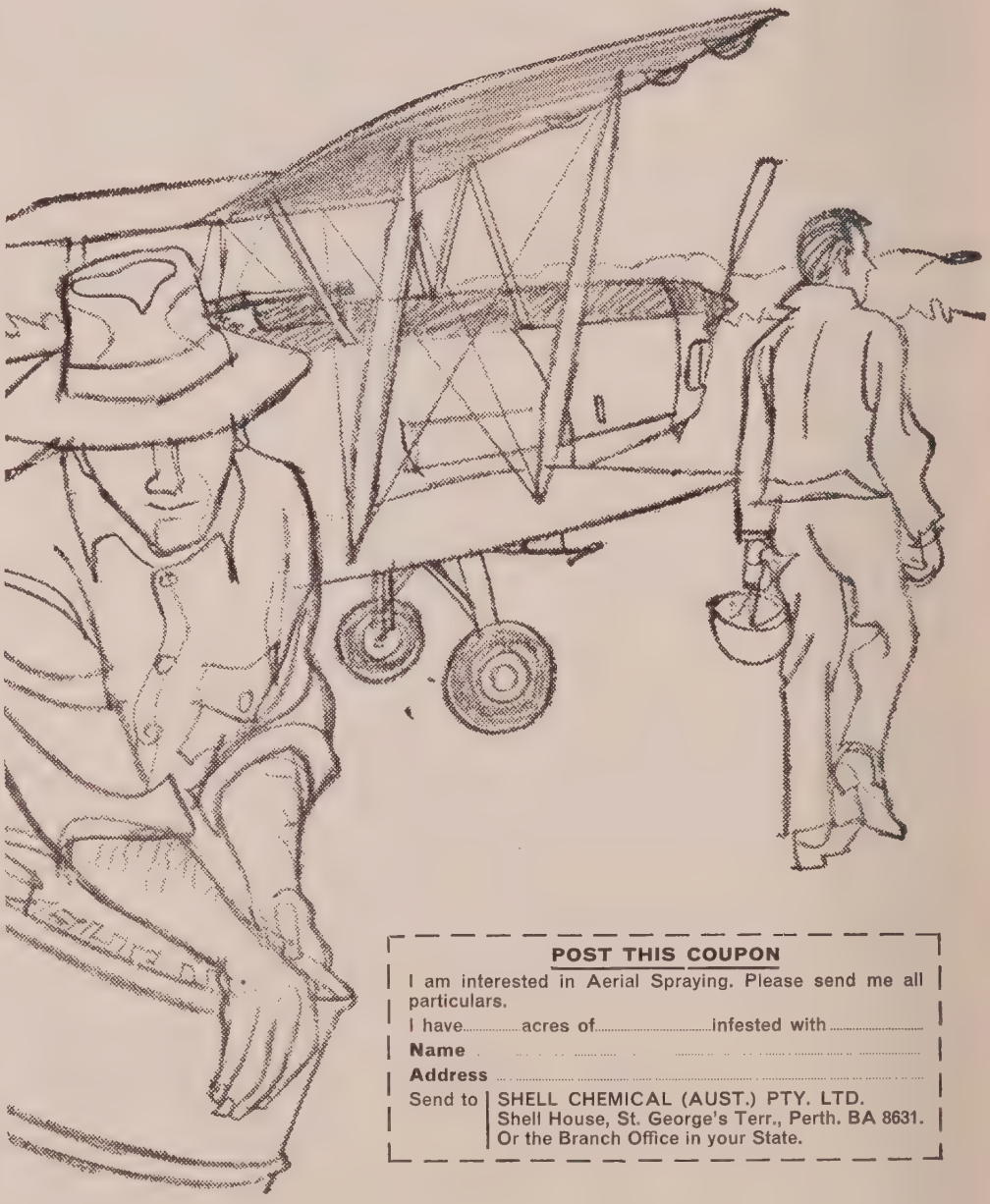
WITH the approach of winter, thoughts are turning to the seeding season. It will therefore be appropriate to discuss methods of establishing saltland pastures. This discussion will be restricted to "bluebush," creeping saltbush, and old man saltbush. Seed of these plants is available from local stock firms.

All three bushes will grow on non-salty as well as on salty ground, and the soil types most suitable are those which support morrel, salmon-gum, gimlet, and york-gum. Very wet areas are not suitable, and usually samphire is the only plant which will colonise these parts. The best results have been achieved on morrel soils.

On areas which are badly salt-affected establishment is hazardous and several years are usually necessary to give a good stand. During the whole of this establishment period grazing animals must be excluded for best results.

Preparation for sowing should start, if possible, before the opening rains. This initial roughening may be done any time after the feed dies off in spring and up till the first rains: the purpose is to break the surface seal which occurs on salty soils in order that blowing seeds may be collected and the first rains will soak into the soil and leach as much salt as possible away from the surface. The soil should be worked with a narrow pointed implement to a depth of three to four inches. On close-tyned implements some tynes may be held out of the ground as overall working is not required. The surface should not be left smooth or powdery. On some soils which blow badly it may be advisable to leave the roughening until autumn. On slopes, the working should be on the contour, if possible.

A second working after the rain may be of assistance, especially if the soil has been flattened by the rain. On very salty areas the killing of any plant should be avoided



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since cover is too valuable to waste. On areas only mildly affected, grass can cause serious competition to young bluebush and saltbush seedlings and some thinning of the grass may be beneficial. If it is not possible to fit in a second working or it is considered unnecessary, the seed of any of the three plants may be spread on the surface by hand. Very shallow sowing is required and the seed is usually buried sufficiently by rain washing. If a second working is given, the seed should be spread on the surface of the ground after this second working. The actual spreading should not take place before the area has received about an inch of rain, and should be no earlier than mid-May.

Superphosphate should be applied at about half a bag to the acre on mildly salt-affected country but on worse areas the rate should be less to avoid waste. It is not now considered advisable to mix the seed with the super for sowing.

A cover crop is valuable in areas affected by wind-blow. Cereal rye sown at about 40 lb. to the acre will give good protection.

Unfortunately, red-legged earth mites, lucerne fleas, and grubs of some types attack bluebush and saltbush seedlings. If these pests are present in large numbers they can easily wipe out all the seedlings. Details of spray control methods are set out in two departmental leaflets on mite and flea control.

Both bluebush and saltbush seedlings are delicate in the early stages of growth, but once the true leaves have begun to appear, hardiness increases rapidly. Young bluebush seedlings only an inch high are extremely drought-resistant. However, young plants of all three species can be quickly killed by grazing animals.

When large bushes have been established they will provide seed supplies for colonising areas in between. Roughening between the older bushes will encourage seed trapping and help thicken the stand. Bluebush will spread its own seed. Creeping saltbush spreads slowly, but old man saltbush seed must be picked in summer or autumn and spread at sowing time, since it does not spread of its own accord.

Persistence is perhaps the greatest asset in colonising salt areas, because it takes time to repair soil damage which has usually taken a number of years to develop.

THE USE OF LIME IN MARKET GARDENS

THE term "lime" when used in relation to agriculture means any calcium-containing material that is capable of correcting soil acidity. While generally used for this purpose, lime has many other equally important functions in the soil.

The element calcium occurs in a large variety of minerals, and may be quite abundant in soils derived from limestone rocks. However, it is readily soluble, and can be leached out very easily; more easily from light sandy than from heavy soils.

In low rainfall regions there is little need for liming because the lime reserves have not been leached away or removed by crops to any great extent.

With heavy rains, or continuous heavy irrigation, frequent dressings with lime or limestone may be necessary, especially is this the case with older soils, after most of the calcium had been washed out or removed by the crops.

The removal of calcium from the soil will result in two things. Firstly, there will be a shortage of calcium for healthy plant growth; and secondly, soil acidity will increase. Increased acidity, in turn, will have several undesirable effects. It has an important effect on the solubility, availability and sometimes toxicity of a number of elements. Many of these elements are essential for normal plant growth.

As acidity increases, the solubility of aluminium, copper, iron, manganese and zinc also increases. Sometimes toxic concentrations of these elements may occur in highly acid soils. Acidity and liming also indirectly affect the availability of the three major plant nutrients, nitrogen, phosphorus and potassium.

Generally, an increase in soil acidity adversely affects nitrogen-fixing bacteria associated with the roots of legumes and

those living free in the soil. As a result, the availability of nitrogen declines. Soils contain a variety of micro-organisms, such as bacteria, fungi, and other kinds. These are very active in decomposing organic matter in the soil, and thereby releasing plant nutrients. The numbers and kinds of micro-organisms present in the soil may vary according to the degree of acidity, moisture content, amount and composition of organic matter. Acid conditions may reach a point where the activity of these organisms in decomposing organic matter declines or even ceases.

Crops differ as to the degree of acidity at which they grow and produce best. They also differ in the amount of calcium required for their nutrition. Potatoes, rhubarb and water-melons can grow and produce satisfactory crops in highly acid soils. Least tolerant to acidity are the legumes and leafy vegetables. These also require considerable amount of calcium for their growth.

The application of lime then, first of all supplies readily available calcium for healthy plant growth. Gypsum, or land plaster as it is often called, is an excellent source of calcium and sulphur for plants, and may have a favourable effect on soil structure. But it does not correct soil acidity, and therefore it is not a liming material. Gypsum is often used as a soil conditioner for excessively alkaline soils. The second important effect of liming is the correction of soil acidity, and through this, its indirect effect on the availability of major plant nutrients, activity of soil micro-organisms, and other important effects.

There is a wide variety of liming materials. The most commonly used ones are ground limestone, burnt or quicklime, and hydrated lime. The last two are derived from limestone; they are very active chemically, rather unpleasant to handle and difficult to store. Foliage may be damaged through contact with quicklime. In spite of these drawbacks, it may be advantageous to use quicklime or hydrated lime when a rapid decrease in soil acidity is desired, as, for instance, when we want to grow vegetables that have a high lime requirement, or where a lime-requiring crop follows potatoes. When limestone is used, the small particles react immediately, but the larger-sized ones will give a reaction over an extended period. The appearance of some diseases may sometimes be taken as an indication of a particular acidity status of the soil. For example, clubroot of cole crops only occurs in rather strongly acid soils, whereas potatoes are likely to become scabby as the soil acidity is reduced from strong to medium.

The amount of lime to be used depends on the kind of liming material and the degree of acidity. About 1,000 lb. of quicklime or 12,000 to 14,000 lb. of hydrated lime are equivalent to one ton of ground limestone. The degree of acidity can only be ascertained by laboratory tests, and here, of course, the help of your local adviser will be needed. To correct acidity, light sandy soils react quicker and require less liming material than do clayey soils.

Most forms of lime may be applied at any time of the year. However, when lime stone is used it is a good practice to apply is as long as possible before planting to enable it to react with the soil.

The use of excessive quantities of lime may have serious consequences. It may be accompanied by a reduction in the availability of such nutrients as boron, magnesium, manganese, copper and zinc. This is especially probable where the supply of these elements in the soil is low. On some soils, excessive use of lime seems to interfere with the absorption of phosphorus and potassium. The use of very active limes, such as quicklime or hydrated lime, is more likely to cause over-liming, especially in sandy soils, low in organic matter.

To determine whether or not lime should be used, and especially, what quantities to apply, one has to take a number of factors into account. The type and acidity of the soil, kind of vegetables to be grown, previous fertilising, manuring and cropping history of the ground, availability and comparative costs of liming materials are some of these factors.

Considering the possible dangers associated with improper use of lime, it might be advisable to contact your local adviser before lime is applied. He will be in the position to give you detailed advice.

CAN WORMS BE CONTROLLED BY CORRECT FEEDING?

By L. C. SNOOK, D.Sc.,
Animal Nutrition Officer

THE extensive losses which result from the ravages of internal parasites are a matter of serious concern. Livestock owners realise this all too well and welcome advice concerning control measures which can be adopted. Unfortunately, it is not possible to give clear cut advice on the subject. Much publicity is given to the use of drugs which will expel the worms. Various systems of strategic drenching have been developed. Considerable time and money is being spent on research programmes designed to obtain more efficient drugs, and to learn more about the weak points, if any, in the life cycle of the offending parasites. All this work is building up an effective weapon which can be used by the stockowner to attack the problem of "worms." It is well to remember, however, that drenching is only one of many methods which can be used to control worm infestation. In this talk attention will be concentrated on experimental evidence which shows that good husbandry in general, and good feeding in particular, may greatly reduce the worm burden carried by livestock.

It is significant that many of our most successful stockmen never use drenches in any form. Fat lamb breeders with excellent records extending over many years can be quoted in support of this statement. Likewise, many champions at the Royal Show come from studs where worm drenches are never used.

Several years ago fat lamb breeders in Victoria sent a representative to New Zealand to see what could be learnt in that country. In his report (Pastoral Review, 16/10/1957, 1187) this representative describes one of his outstanding impressions as follows "I was surprised to find that farmers as a rule do not drench their ewes or lambs *at all.* I was told that drenching had decreased over the last few years, because experience has shown that unless a sheep has been weakened by some predisposing cause such as malnutrition, or a marginal cobalt deficiency, it will *not* suffer from a build up of worms at high stocking rates. New Zealand farmers believe that drenching is unnecessary when sheep are fed enough of the right type of feed at the right time." This ends a quotation characteristic of the statements made by those who believe that good feeding is the main bulwark against infestation with worms. Dr. McMeekan (1957) gives more specific information on this point when discussing the results obtained when pastures were stocked at the rate of four, six, and eight breeding ewes per acre. He states "There was no difference in ewe deaths, in lambing percentages, in lamb losses, while the worm burden carried by the lambs at slaughter was identical under the three stocking rates. No trouble was experienced with worms, and no drenching of either ewes or lambs was found necessary. These points are worth remembering, if only to remove the fears of some sheepmen in respect of possible hazards of heavy stocking with sheep." It is of particular interest to note that in these New Zealand trials the lambs did not carry any more worms under the conditions of heavy stocking.

Considerable experimental evidence has been accumulated concerning the effect of nutrition in controlling the number of worms carried by infected animals. In the March issue of "Rural Research, 1960," for example, trials are described in which lambs aged two and a half months were given heavy doses of black scour worm. Half the lambs which were on a poor ration, died as a result but *all* the well-fed lambs survived. In this publication prepared by the C.S.I.R.O. the clear cut statement is made that "Well fed sheep are better able to withstand *and throw off* infestations."

In most flocks of weaner lambs there is a "tail," that is a percentage of lambs which lack size, and appear to be unthrifty. Generally these unthrifty lambs carry a heavy burden of parasites. Did these lambs become unthrifty because of the worms? Or were the parasites able

to develop because the lambs were unthrifty? These are basic questions. Experiments have shown that youngsters which receive a plentiful milk supply from their mothers, are much more resistant to infection from worms than are similar animals on the same pasture whose mothers have a poor milk supply. It could well be that the unthrifty "tail" in the weaner flock represents lambs from mothers with a poor milk supply. Dr. J. H. Whitlock (1951) makes this statement in the "Cornell Veterinarian." "It is not unlikely that the diet the ewe is fed, the condition of her udder, her general condition, her genetic constitution, all of which can limit milk production, are at least as important as the pasture contamination she produces." It could well be that if ewes are bred, *and fed,* to supply plenty of milk, the problem of worms in lambs will no longer be a serious one.

The protective value of the milk supply was shown very clearly in trials with baby pigs exposed to infection with the larvae of round worms (Ascaris). On a diet of rolled oats, the young pigs became infected with as many as 657 of these large worms. The piglets receiving milk also became infected. This particular worm, when first it develops, gets into the blood stream and can cause pulmonary symptoms as it escapes into the lungs. In the piglets receiving milk the young worms reached the lungs where they produced the characteristic reaction but they failed to become established in the bowel. In 1958 a similar type of result was reported with dairy calves which were infected experimentally. Those receiving a full complement of milk had less worms than those receiving hay and grain in addition to the milk. The observation was made that in the milk fed groups the worms did not grow to their full size. There were less worms in the tracts of the unweaned calves than there were in the weaned calves. This evidence is quoted because one so often hears the statement that good feeding will not reduce the actual number of worms in an animal.

It is not only milk which will help an animal to cast off a parasitic infection. In some interesting trials carried out in the U.S.A., at the New Georgia Experimental Station, it was found that calves grazing on a fescue grass pasture carried more worms, and showed ill-effects, in comparison to similar calves which were placed on red clover, or good mixed pasture. By adding maize to the diet of the calves on the fescue the number of worms was reduced by two thirds and the weight gains of the calves showed a significant increase. There was here no need to drench the affected animals to remove the worms. All that was required was to correct the deficiency in the diet. In many cases, unfortunately, we do not know just what is the weakness in the diet which has to be corrected. In the absence of this knowledge drenching necessarily remains an important bulwark of defence. But while the drenching is being carried out an attempt should be made to determine the weakness in the system which enables the worms to thrive. The importance of this approach is illustrated very well in Information Circular No. 16, published by the C.S.I.R.O. concerning a problem with weaners in the Northern Tablelands of N.S.W. Worms were numerous in these young sheep and in some years a third of the flock would die with heavy infestations of nodule worms. A series of supplements were tried without any beneficial effect. It was then found that if the weaners were placed on green oat crops the infestation would be thrown off in a matter of several months. Of more importance, losses no longer occurred and the animals gained considerable weight. In contrast the controls lost weight. Obviously a change in livestock husbandry which will effect these improvements is to be preferred to a drenching programme which, at the best, can only reduce the worm burden.

It would appear that if *any* essential nutrient is lacking in the diet this can increase the susceptibility to worm infestation. Mineral deficiences can be particularly serious. As an extreme example one can quote an experiment carried out in America (Emerick *et al,* 1957) in an area where as many as 28 per cent. of the lambs died despite a supplement of salt plus trace elements. Phenothiazine drenches were effective in reducing these losses and in promoting good growth rates. But supplements of calcium phosphate were equally effective and were much less trouble to the farmer.

The importance of mineral supplements has been demonstrated in many experiments carried out in South Africa, under climatic conditions similar to our own. In a number of scientific journals the opinion is expressed that even where stock receiving mineral supplements still carry worms, these animals do much better than their fellows which have been drenched to remove the worms but which still suffer from the mineral deficiency. If too much faith is placed in a drenching programme, it is probable that the urgent necessity to correct a dietary deficiency will be overlooked.

When a productive pasture is heavily grazed it is estimated (Taylor, 1944) that a sheep may ingest as many as 8,000 parasites in one day. Obviously the grazing animal must necessarily be endowed with defensive mechanisms or it would be overwhelmed by this massive infection. Every opportunity should be taken to make use of these natural defence mechanisms. That these can be effective has been demonstrated very effectively in long term trials carried out at the C.S.I.R.O. Regional Laboratory near Armidale in N.S.W. Here the improved pastures, which are heavily stocked, seem an ideal environment for the development of a serious worm problem. But the Research Officers have shown that weaners on these pastures do not show any benefit from regular monthly dosing with phenothiazine. In contrast sheep on unimproved native pastures at a low stocking rate can be severely infested with worms unless regularly drenched. Here we have an object lession for the many farmers in Western Australia who have a worm problem in flocks running on partially improved country. It seems more logical to determine, *and correct,* the probable deficiencies in the diet of these animals, rather than to continue to depend on drenches to eliminate the worms. It is significant, for example, that in the many areas where cobalt deficiency is known or suspected, internal parasites are also a serious problem. Likewise, it is no mere coincidence that lupinosis is associated with heavy infestations of worms. Perhaps if one could correct the deficiencies in the diet, so that the animals can develop their normal resistance to parasitic infection, simultaneously there may be an alleviation of the lupinosis problem. The deficiencies in question are not necessarily simple ones—maybe there is a shortage of several essential nutrients. The deficiency hypothesis could even be a false one, but it appears worthy of study.

In this talk attention has been restricted to the importance of good feeding in the control of "worms." Any nutritional deficiency, be it energy, protein, minerals or vitamins, will leave stock more vulnerable to attack. Of course, every aspect of the production programme can have some significant effect on the well-being of the livestock. If, despite all efforts, worms remain a problem, it is wellnigh certain that there is a nutritional or managerial weakness somewhere. So if drenching remains a necessity, set out to discover the weakness which exposes your animals to attack. In no aspect of rural production is it more true to say that "Prevention is better than cure."

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